REPORT DOCUMENTATION PAGE	*Form Approved* *OMB No. 0704-0188*

1. AGENCY USE ONLY *(Leave blank)*

2. REPORT DATE
9 Jan 96

3. REPORT TYPE AND DATES COVERED

4. TITLE AND SUBTITLE
Visual Search In Consumer Nutrition Labels

5. FUNDING NUMBERS

6. AUTHOR(S)
Robert E. Zak

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Pennsylvania State University

8. PERFORMING ORGANIZATION REPORT NUMBER
96-104

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
DEPARTMENT OF THE AIR FORCE
AFIT/CI
2950 P STREET
WPAFB OH 45433-7765

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION AVAILABILITY STATEMENT
Unlimited

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

14. SUBJECT TERMS

15. NUMBER OF PAGES
90

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT

Standard Form 298 (Rev. 2-89) (EG)
Prescribed by ANSI Std. 239.18
Designed using Perform Pro, WHS/DIOR, Oct 94

The Pennsylvania State University

The Graduate School

VISUAL SEARCH IN CONSUMER NUTRITION LABELS

A Thesis in

Industrial Engineering

by

Robert E. Zak

Submitted in Partial Fulfillment
of the Requirements
for the Degree of

Master of Science

December 1996

We approve the thesis of Robert E. Zak.

Date of Signature

Joseph H. Goldberg
Associate Professor of Industrial Engineering
Thesis Adviser

11/19/96

Claudia K. Probart
Associate Professor of Nutrition

11-22-96

Allen L. Soyster
Professor of Industrial Engineering
Head of the Department of Industrial and
Manufacturing Engineering

11/22/96

ABSTRACT

The purpose of this study was to investigate the effect of the graphical layout of nutrition labels on their readability. Little empirical information is available on the value of the multiple enhancements incorporated into the design as mandated and standardized by the Nutrition Labeling and Education Act of 1990. Eye movement recording offered an attractive technique to explore consumer's cognitive processes while reading the labels.

Eight women and two men between 19 and 41 years of age had their eye movements recorded while reading sample nutrition labels. Participants were evenly divided into two groups based on their level of experience in using nutrition label information. Their task was to search for and extract prescribed nutritional values from the labels. A 5 x 3 x 3 x 2 x 2 factorial design was employed with five levels of anchoring and alignment lines, three presentation times, three target locations, two label sizes (information content) and two subject experience levels. Dependent variables were landing distance (in degrees) from initial capture fixation position to target (LD), total number of fixations until initial target capture (NF), total time until initial target capture (CT), target search time (ST), and initial capture fixation time (FT).

Of the main effects, subject experience level was significant for NF ($p<0.01$), ST ($p<0.05$), and FT ($p<0.05$), condition (anchor and alignment lines) for NF ($p<0.05$), CT ($p<0.001$), and ST ($p<0.01$), presentation time for NF ($p<0.001$), CT ($p<0.001$), ST ($p<0.001$) and FT ($p<0.05$), and target location for NF ($p<0.001$), CT ($p<0.001$), and ST ($p<0.01$). Significant interactions were identified for experience and presentation time for

NF ($p<0.05$), CT ($p<0.05$), and ST ($p<0.01$). Interactions of condition and target locations were significant for the same three variables at $p<0.001$.

Anchor lines did not play a positive role in search strategies as some of the fastest times were recorded for the no anchor line condition. Experienced subjects landed closer to the targets, arrived there faster and stayed on the capture fixation longer than subjects at lower experience level.

The current study validated, for the label variables tested, the prevailing nutrition label design as optimal, regardless of experience level. Any changes to the standard label design negatively affected both experience level groups about equally.

This research has implications beyond nutrition labels. Warning instructions can utilize these findings to enhance their readability. Instructions that must be followed in the in a certain order and where exact numerical values must be extracted could be improved with the inclusion of alignment lines.

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ACKNOWLEDGMENTS

I would like to express my thanks to my adviser, Dr. Joseph H. Goldberg, for his guidance and understanding throughout the preparation of this thesis. I would also like to thank my fellow students in the Human Factors Laboratory for their support and help throughout the past two years. I would especially like to thank Esa Rantanen and Daniel Callan for all their contributions to this cause.

Above all, I would like to thank my wife, Mary, and daughters, Renee, Samantha, and Erica, for their patience, love, and support throughout this program. Without their help, prayers and understanding none of this would have been possible.

Chapter 1

INTRODUCTION AND LITERATURE REVIEW

1.1. Nutrition Facts Labels

1.1.1. Background

In 1906, the federal government enacted legislation to regulate the safety and quality of foods (FDA, 1993a). Prior to 1906, food packages were not required to contain any information about the product. The Federal Food, Drug, and Cosmetic Act of 1938 required the label of every processed, packaged food to contain only the name of the food, its net weight, and the name and address of the manufacturer or distributor. A list of ingredients was required only on certain products and false or misleading statements were prohibited. In 1973, the Food and Drug Administration (FDA) issued regulations that required nutrition labeling on food containing one or more added nutrients or whose label or advertising included claims about nutritional properties. Nutrition labeling was voluntary for all other foods. Sodium was added as a required item and potassium as an optional item in 1984. In the latest round of legislation the Nutrition Labeling and Education Act (NLEA) of 1990 was enacted to require that nutrition labels be added to nearly all packaged food items, standardize the presentation of nutrient information, and establish guidelines on recommended daily limits of these nutrients in an easily readable

form (FDA, 1993a). In a study on new formats for labels, Levy et al., (1991) found that consumers wanted a short, easy-to-read, and easily interpreted food label that provided more information than the label being replaced did. However, performance results indicated the label utilized before the passage of the NLEA of 1990 enabled consumers to more effectively discriminate nutrition differences among products, and additional information hindered search performance (Levy et al., 1991).

As a result, the development of the new label took into consideration comments from consumers, food manufacturers, and health professionals on what they considered to be important information that should be included on the food labels. The final format regulations, as defined by the January 6, 1993 Federal Register, was a consensus of the comments and concerns received during the hearings period (FDA, 1993b). The labels, as mandated, were designed to be conspicuous on store shelves and follow a standardized format for the presentation of nutrition content (see Figure 1.1). The label shown is a full-sized version, which contains the highest information content required by law. Some variations to the format were allowed if the packaging did not have enough label space to accommodate the full-sized version, or if certain nutrients normally required on the label were not found in significant amounts in products (FDA, 1993b). An example of the former is canned tuna while an example of the latter is a soft drink beverage. The soft drink label shown in Figure 1.2 is an example of a simplified, low information content variation.

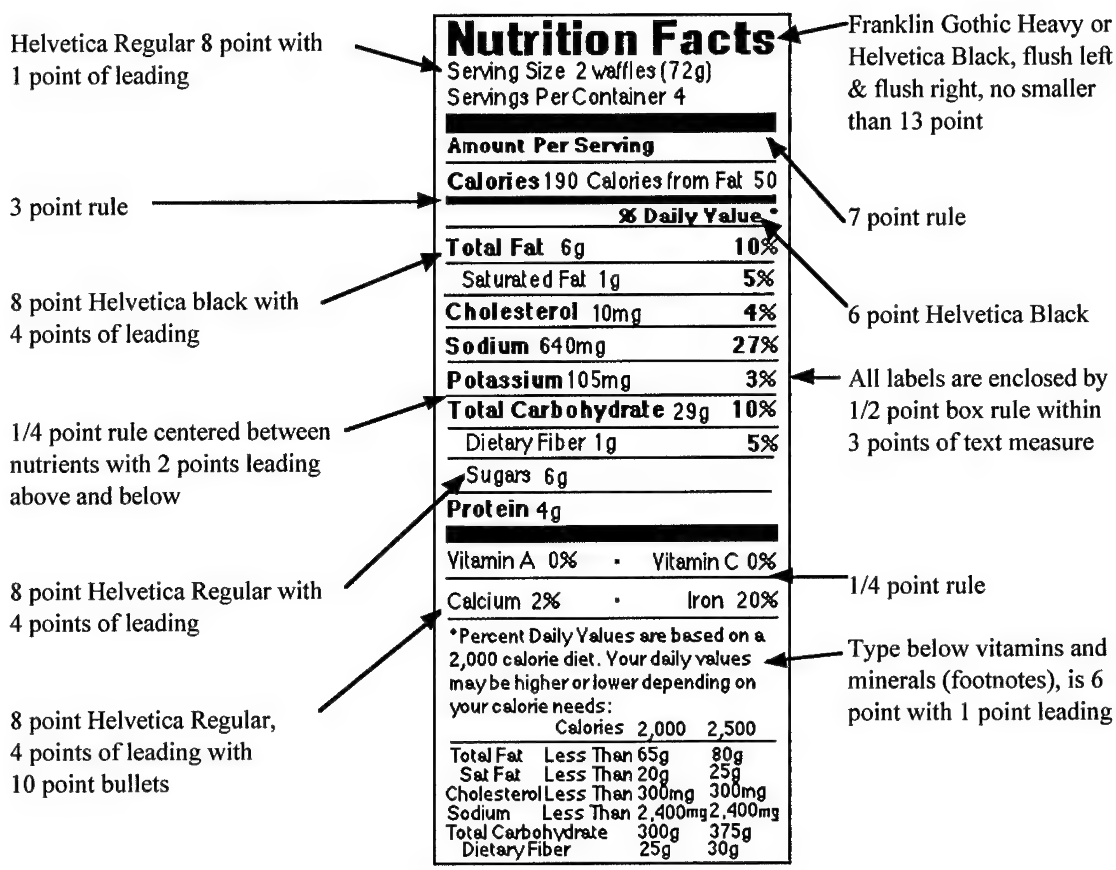


Figure 1.1. Nutrition facts label minimum requirements
(adapted from Federal Register, January 6, 1993)

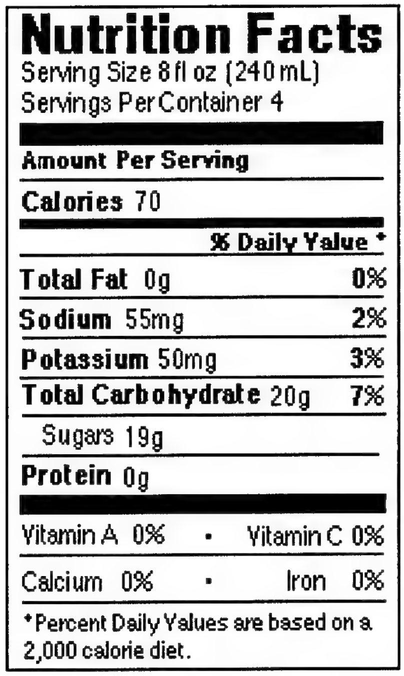


Figure 1.2. Nutrition Facts label, simplified version.

Bender and Derby (1992) reported that 74 percent of consumers used nutrition labels. Label utilization, however, focused on avoiding selected food components, rather than on using labels as a guide to overall healthful eating, the intent of the NLEA of 1990 (FDA, 1993b). Bender and Derby (1992) found that consumers who use nutrition labels were more likely to be young (25-34), white, female, better educated, and follow a self-initiated or doctor-prescribed low-sodium or low-cholesterol diet.

The Food Marketing Institute (1995) reported that shoppers made an average of 2.2 trips to the grocery store during a week. Of the number of shoppers who read labels, seventy-eight percent were aware of the recent changes in the wording and format of the nutrition label. Only 80 percent of shoppers aware of the new label format thought they were more understandable.

1.1.2. Label Enhancements

To enhance noticeability of warning labels, Laughery et al. (1993) cited label guidelines that suggested the use of salient features to draw attention to warnings. Salient features enhance the foreground by making it visually distinct from its background. Examples of salient features include size, pictorials, colors and bordering. The final design of the Nutrition Facts label has incorporated the "more is better" philosophy in its development, with no less than seven such salient features.

In addition, Laughery et al. (1993) further explained that there is little or no information as to whether features work together additively or certain combinations interact in a more complex way. Similarly, federal law mandated (FDA, 1993a) the use of many salient features to the design of the nutrition labels. Among the features incorporated into the design were: 1) san serif font, 2) large, bold font heading, 3) bold font on mandatory nutrition items and percent daily values, 4) optional nutrient amounts are indented, 5) border around label, 6) heavy ruled lines dividing label into sections, and 7) tabular layout of information. In a study of perceived readability of warning labels, Silver and Braun (1993) found results supporting the use of selective highlighting with bold text, use of font sized of 8-point to 11-point, and Helvetica font type (san serif). These were all incorporated into the design of the current nutrition label. The label also included 1/4-point ruled lines between all nutrient, vitamin, and mineral information. These lines could be thought of as alignment lines that aid in locating information.

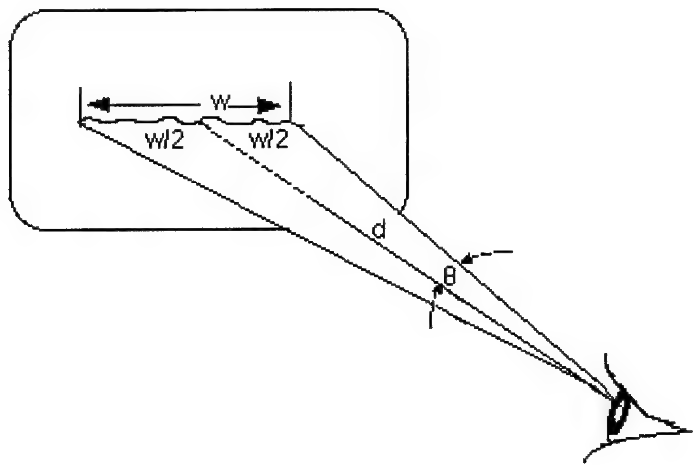
1.2. Perception and Comprehension of Visual Information

Visual perception results from a series of optical and neural transformations. Light that arrives at the eye is transformed by the cornea and lens, which focus light and create an image on the retina at the back of the eye. The retina is a thin layer of neural tissue that covers an area of about 5 cm by 5 cm. The retinal image is then transformed into neural responses by the light-sensitive elements of the eye. The fovea is a relatively small, 1.5 mm (1-2 degree) angular region of the retina within which there is greatest visual acuity (Wandell, 1995).

Visual scanning is a discrete process that is broken into periods of about 300 msec during which the eye is relatively immobile (fixations), separated by quick jumps of the eye from place to place (saccades). Saccades are quick, approximately 50 msec, ballistic movements of the eye that let the eye catch up with the target being scanned. Visual information processing is assumed to take place during fixations, whereas vision is suppressed during saccades (Latour, 1962; Volkman, 1976), though not entirely. Bridgeman and Fisher (1990) found saccadic suppression strongest in central vision but weakened in the periphery. This suggests that some useful information can be processed during saccades. Fixations generally last between 200 and 300 milliseconds. Under normal conditions, there are thus, a maximum of three to four fixations per second.

Just how much visual area is covered in each visual fixation? It is clear, on the one hand, that the eye can sometimes take in information from peripheral vision. On the other hand, resolution of fine visual detail requires the highest acuity region of the fovea, an angle of no more than about 2 degrees surrounding the center of fixation. Mackworth (1976) addressed this uncertainty by defining the "useful field of view" (UFOV) as a

circular area around the fixation point from which search information is extracted. Data collected by Mackworth and others suggest that the size of the UFOV may vary from around 1 degree to 4 degrees of visual angle. Visual angle of a character (or line of characters) determines the retinal image size, or effective visual size, of reading material. This angle is determined by the horizontal width of the line and the distance the reader is located from it (See Figure 1.3).



$$VisualAngle(\deg), \tan\frac{\theta}{2} = \frac{w}{2d}$$

Figure 1.3. Schematic diagram of how visual angle is calculated (Adapted from Gould and Grischkowsky, 1986).

The size of the UFOV appears to be determined by the density of the information and by the discriminability of the searched-for target from its background. The size of this area depends, among other things, on characteristics of the visual target and the surrounding context. The UFOV is narrow when the target is embedded in a complex background or

surrounded by irregularly positioned non-target items (Brown & Monk, 1975), when the density of non-target items and the visual load increase (Mackworth, 1976), or when the similarity of target and non-target items is high (Bartz, 1976). Thus, looking for a dark flaw on a clear background in glass inspection will lead to a larger UFOV than scanning for a misaligned connection in a circuit board or microchip (Wickens, 1992). A 5 degree UFOV may be a reasonable choice. Data of Blackwell and Moldauer (1958) and Taylor (1961) showed that relative visual acuity approximately halves at a distance of 2.5 degree from the point of fixation. This is consistent with data of Bouma (1970), which showed that when a letter was flanked by other letters and presented at 2.5 degree, it was reported with half the accuracy of a letter at the fixation point. The 5 degree UFOV is consistent with Danchak (1976) who selected a 5 degree circle as the basis for calculating the recommended maximum length for a displayed word.

In a study by Helsen and Pauwel (1990) that focused on expert vs. novice search strategies, experienced soccer players made fewer fixations during a tactical problem solving experiment than inexperienced players. It was concluded that expertise leads to an economy of visual search characterized by fewer fixations and shorter fixation times, the end result being better performance (Helsen and Pauwel, 1990).

1.3. Label Information

Montgomery (1991) defined a quantitative factor as one whose levels can be associated with points on a numerical scale. A qualitative factor, on the other hand, is a factor for which the levels cannot be arranged in order of magnitude (Montgomery, 1991). A method examined for quantifying printed information was one put forth by Tullis (1983).

Tullis proposed a method to calculate overall density of printed matter on displays. This was done by expressing the actual number of characters shown as a percentage of total available character spaces. Due to the variability of font size, the information on the nutrition labels for this study were treated as chunks of information. The words "serving size" would serve as a chunk of constant information. All labels contain that wording and presents no new information to the reader, thus it serves as an anchor only. Other examples of constant chunks would be "sodium" and "total fat." On the other hand, the actual serving size of "1 waffle" is unique for one food item and would change as the food item changes. This is an example of a chunk of variable information, which provides new information to the reader. Chunking information is supported by Miller (1956), due to limitations of human working memory with capacity for seven pieces of information at one time, plus or minus two. A telephone number can be thought of as seven pieces of information or two chunks of information, a three number prefix along with a four number suffix. However, these memory capacity limitations may be exceeded via efficient coding of each of these chunks.

Some of the information in nutrition labels is constant. For example, the label heading, "Nutrition Facts," remains constant in all cases. This is one chunk of constant information. For this study, the large nutrition labels (see Figure 1.1) with all required nutrition information and footnote items included was designated as having a high information content. The full-size large labels typically contain 22 chunks of constant information, which remains the same for all of the high information images. There are 25 chunks of variable information that will change with each label. An example of a variable chunk of information would be the actual calorie value, which would change with the product. Contained in the smaller, low information labels (see Figure 1.2) are 17 chunks of constant information and 18 chunks of variable information. The small labels have 28

percent less variable information chunks than the full-sized labels and 23 percent less constant information chunks than the large labels (see Table 1.1). Refer to Figures 2.1 and 2.2 for examples of the variable chunks of information used as potential targets.

Table 1.1. Nutrition label information content.

	Information Content	
	High	Low
Constant Chunks	22	17
Variable Chunks	25	18

1.4. Anchoring

An anchor is a starting point bias that influences decisions. Anchoring occurs when uninformative starting points are influential or when informative starting points are overly influential (Chapman and Johnson, 1994).

In Tufte's (1983) theories on improving the visual display of quantitative information, he pointed out that data graphics could be enhanced by perpendicular intersections of lines of differing weights. The contrast in line weight represents contrast in meaning with the greater meaning given to the greater line weight. The heavier line should be a data measure receiving greater weight than the connecting verticals (Tufte, 1983). Conversely, when the heavier weight line does not represent a data measure, as in nutrition

labels, its inclusion could cause it to draw the attention of the reader away from the pertinent data and act as a distractor. The inclusion of the heavy lines could also have an anchoring effect. Since the lines are always in the same position, the relative distance of some information from those lines could be kept in the memory of experienced label readers, which could aid in finding information faster than if no lines were present. There are three possible anchoring lines on the nutrition facts labels. A seven-point ruled line is located between Servings Per Container and Amount Per Serving. A three-point ruled line is located between calorie information and the label "% Daily Value." The third potential anchoring line is a seven-point ruled line that separates the nutrients from vitamin information.

The ruled lines on the label serve the purpose of separating the label into three major sections; 1) the serving size information (top), 2) nutrient information (middle), and 3) vitamin, mineral, and footnote information (bottom) (see Figure 1.3). An earlier pilot study of undirected search of labels that led to this study showed that subjects spent nearly one-fourth of the presentation time fixating on information in the top section of the label, which has only four chunks of variable information and three chunks of constant information. The images were all of the high-information content, federally mandated variety. The high number of fixations in the top section of the labels would seem to support Krose (1986) (as cited in Boersema et al., 1989) who found that the presence of distractors in the visual field increased the number of fixations necessary to locate a target with the extra fixations being located on, or in the direction of the distractors. The ruled lines appeared to be strong distractors, even though they also aided the reader as anchors.

1.5. Objective

The goal of this research was to investigate the effect anchoring and alignment lines had on reading nutrition labels on food packaging. The study explored how changes in thickness of anchor lines and the removal of some or all alignment lines affected subject performance in a search task, as well as the effect that length of time of presentation had on subjects of both high and low experience utilizing the labels. Data gathered included the number of correct answers to qualitative questions about the displays shown, total number of fixations made during a trial, and total time of fixations.

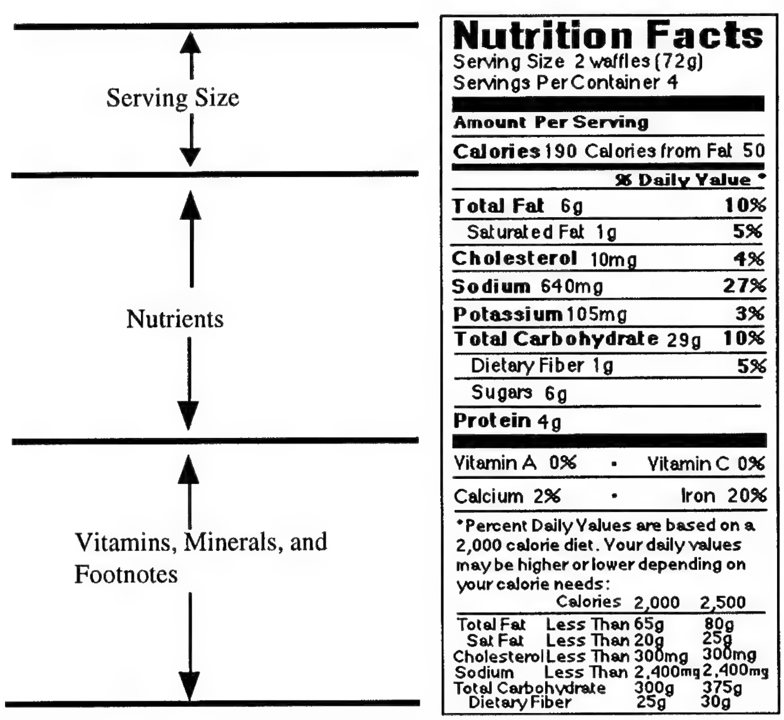


Figure 1.4. Separation of nutrition label into informational content sections.

Novice nutrition label readers should take longer to find the required information than experienced readers. It was also hypothesized that there would be more fixations on labels where the anchors are within the useful field of view of the targets with explicit fixations on the anchors. With respect to the alignment lines between nutrients, it was hypothesized that the removal of every other alignment line would not affect performance. Properly designed anchoring lines will aid in the location of information as long as the reader has experience with the format of the label. Alignment lines help locate information separated by non-ink areas. Time constraints of the search task will show which label layout can best portray the information in the most efficient manner. These findings should allow for a better, more readable design of the Nutrition Facts labels and increase their usage by the general population.

Chapter 2

METHODS

2.1 Subjects

A total of 10 volunteers were recruited for this experiment. Subjects gave informed consent and received no compensation for their participation. Appendix A shows the university's informed consent letter as well as the form signed by each subject. The subject's vision was tested on a Bausch & Lomb Ortho-Rater vision tester to assure corrected acuity was 20/30 Snellen or better. Subjects were equally divided between nutrition label readers with low experience and those with high experience in reading and utilizing the label information as determined by a background questionnaire (see Appendix B). Less experienced subjects signified they never or seldom read food labels and stated they looked for two or fewer nutrition items on labels. All highly experienced subjects signified they frequently read food labels and looked for four or more items on labels. Subjects not falling into one of these two categories were precluded from testing. Ages of the subjects ranged from 19 to 41 years with a mean of 31.6 years. There were 2 males and 8 females (see Table 2.1).

Table 2.1. Subject characteristics.

Subject	Initials	Gender	Age	Experience
1	PC	Female	36	High
2	ST	Female	25	High
3	CM	Female	19	High
4	EL	Female	30	High
5	DS	Female	25	High
6	ER	Male	35	Low
7	MZ	Female	37	Low
8	JH	Male	36	Low
9	EL	Female	32	Low
10	MV	Female	41	Low
Mean Age			31.6	

2.2 Apparatus

Subject eye scan patterns were recorded by a DBA Systems, Inc. model 626 PC Tracker. The tracker employs an infrared Charge Coupled Device (CCD) camera which records near infrared energy reflected off of the subject's pupil. Eye movements were monitored from the left eye by an infrared light corneal reflection technique. Eye positions were sampled at 60 Hz. The eye tracker was controlled by an IBM-compatible 486 microcomputer with proprietary software supplied by the manufacturer of the PC Tracker system.

Stimuli were generated by a QuickBasic program run on an IBM-compatible 486 computer. The program also collected and stored eye-position data generated by the host eye tracker computer. Data was collected and stored in individual files for analysis. Information collected by the eye tracker included the x,y coordinates of eye positions, time sequence of the coordinates and status of the data points (good data, eye-blink, lost positioning, etc.).

2.3. Stimuli

The stimuli were constructed by electronically scanning a nutrition label, digitizing the image, and opening the image in a drawing package. Artifacts were removed and the font size and type were matched to the existing label so that modifications could be made to the alphanumeric information on the images. The font size for the majority of the label was 10-point Helvetica and Helvetica black. The smallest font that could be easily read on the VGA monitor display was 9-point, so all existing characters of 9-point or larger were kept at that size. Any type smaller than 9-point was increased to 9-points to make it readable. Label information increased to a font size of 9-point included all footnote information plus the headings: 'Amount Per Serving' and '% Daily Value'. All target information were 10-point Helvetica and Helvetica black.

All labels subtended a visual angle of 7.2 degrees (2.6 inches) horizontally when viewed at a distance of 20 inches. Two label lengths subtending angles of 17.8 and 11.7 degrees (6.2 and 4.1 inches respectively) vertically were utilized for the high and low information content labels (See Figures 2.1 and 2.2).

2.4. Experimental Procedure

Subjects were scheduled to participate in the experiment at various times of the day to accommodate their schedules. Subjects signed informed consent forms which explained the purpose and procedure of performing the task in the investigation (shown in Appendix A). They were advised of their right to remove themselves from the experiment at any time.

Before data collection, a background questionnaire (see Appendix B) was given to subjects. The purpose of the questionnaire was to elicit the subject's shopping habits and to gauge the extent of their use of nutrition label information on food packages.

Subjects were comfortably seated in a chair so that their eyes were positioned 20 inches in front of a VGA computer display monitor with 640 x 480 pixel resolution. Subject's head was stabilized by a chin rest to avoid rotational head movements. A practice session of five trials was held before actual testing began to allow each to become familiar with the technique.

Subjects were instructed that they would be shown a series of question screens, starting points, stimuli, and answer screens. The question screen was presented for four seconds. An example of a question was, “Does a serving contain 7g of Total Fat?” A starting point screen was then presented for two seconds and they were required to stare at the starting point until the stimulus image appeared. Subjects viewed the stimulus for either one, three, or five seconds. Immediately after the stimulus, the original question was shown again for another four seconds, after which the responses appeared for four seconds. Light blue gaze spots were shown on the screen where the subjects looked during the answer phase of each trial. Trials began when a question about the image to be shown

was presented on the screen for four seconds. The screen was cleared and a fixation point, 10 pixels by 10 pixels (0.4 degree x 0.4 degree), was presented three inches from the outside, vertical edge of the stimuli in one of six possible positions on either right or left-hand side of the image. The fixation point locations corresponded to the top, middle, and bottom edge of the largest stimulus image on both the right and left sides of the image. Each subject was instructed to fixate on that point until the image was shown. Stimulus images were presented for either 1, 3, or 5 seconds, after which the screen blanked and an answer screen was shown. The subject was instructed to look at the answer they wished to choose. The computer was programmed to use the screen position of where the subject was looking to assign an answer. Possible answers were 'Yes', 'No', and 'Don't Know'. Subjects were instructed not to guess at the answer. Visible light-blue dots were printed on the screen, which corresponded to the center of subject eye fixations made during the answer phase. This aided the subjects and experimenter in verifying answer selection. The screen then blanked and the next trial began. No feedback was given as to whether or not the correct answer was chosen.

2.5 Targets

Targets were alphanumeric characters that represented variable information on the nutrition labels (see Figures 2.1 and 2.2). Only information that was common to both the high and low information conditions were included. The values of the following items were used as possible targets:

a. Serving size (both common measure and metric equivalent)

b. Servings per container

c. Calories

d. Total fat (in grams)

e. Percent daily value of total fat

f. Sodium (in milligrams)

g. Percent daily value of sodium

h. Potassium (in milligrams)

i. Percent daily value of potassium

j. Total carbohydrate (in grams)

k. Percent daily value of total carbohydrate

l. Sugars (in grams)

m. Percent daily value of sugars

n. Protein (in grams)

o. Percent daily value of protein

p. Percent daily value of vitamin A

q. Percent daily value of vitamin C

r. Percent daily value of Calcium

s. Percent daily value of Iron

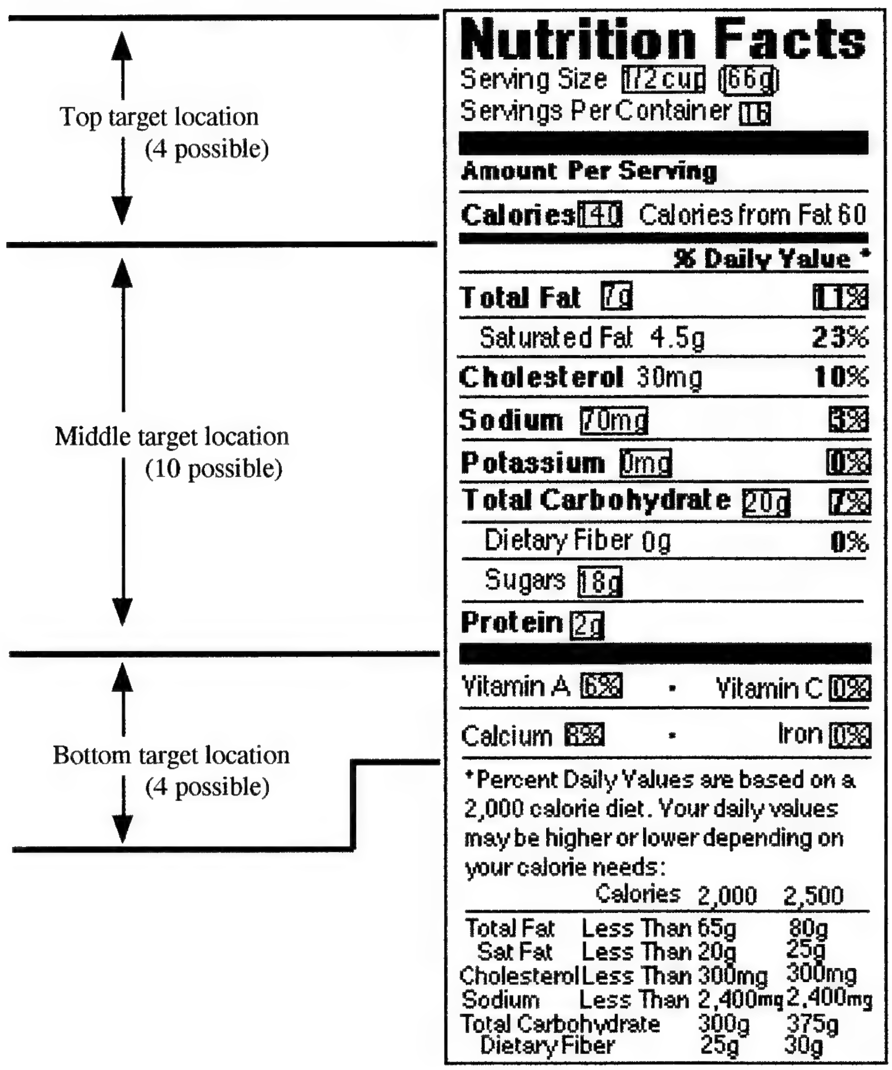


Figure 2.1. Full-size nutrition facts label showing target location, potential targets (boxed values), and number of possible targets within each location.

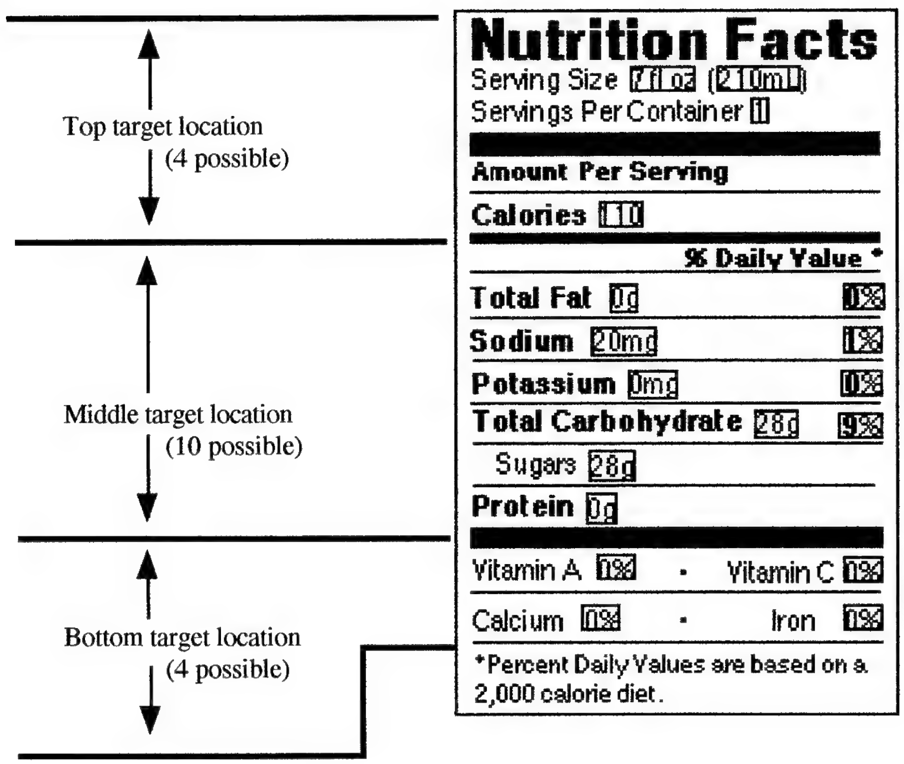


Figure 2.2. Simplified nutrition facts label showing target location, potential targets (boxed values), and number of possible targets within each location.

Targets were located from 9.2 degree to 21.2 degrees from the 6 possible starting fixation points. Targets subtended an angle of .4 degree vertically and ranged between 0.7 and 1.3 degree horizontally.

2.6 Fixation Determination

The eye fixation software program developed for analyzing these trials used the following algorithm:

1. Minimum sample of six eye locations collected.

2. If spatial area exceeded 3 degrees, then gather next sample, increment first sample, and retest.

3. If spatial area not exceeded, increment ending sample point, and determine if spatial area exceeded. If not exceeded, keep incrementing ending sample point otherwise, end fixation.

4. Start next sample with first sample following end of fixation.

5. Continue until no sample points remain.

Blinks and other artifacts were automatically removed by the eye tracker software.

2.7 Experimental Design

The experimental design was a 5 conditions (anchoring and alignment lines) x 3 stimulus presentation times x 3 target locations x 2 information content x 2 experience levels in a fully-crossed factorial. The levels of these five factors were defined as follows:

1. Anchoring and alignment lines (see Figures 2.3 and 2.4) (5) a. Full anchoring, full alignment lines (FA/FAL), b. Full anchoring, partial alignment lines (FA/PAL), c. full anchoring, no alignment lines (FA/NAL), d. No anchoring, full alignment lines (NA/FAL), e. Partial anchoring, full alignment lines (PA/FAL).

Full anchoring included two 7-point ruled lines and one 3-point ruled line (See Figures 2.3 (a), (b) and (c) and 2.4 (a), (b), and (c)). In the partial anchoring condition, the two 7-point ruled lines were replaced with 3-point ruled lines (See Figures 2.3 (e) and 2.4 (e)). The no anchoring condition replaced the two 7-point ruled lines and the 3-point ruled line with 1/4-point rules lines that matched the alignment lines (See Figures 2.3 (d) and 2.4 (d)). Full alignment lines had 1/4-point ruled lines between all nutrient, vitamins and minerals in the Nutrients and Vitamins, Minerals, and Footnotes sections as shown in Figures 2.3 (a) and 2.4 (a). In the partial alignment line condition, every other 1/4-point line was removed from the label (see Figures 2.3 (b) and 2.4 (b)). No alignment line condition removed all the 1/4-point ruled lines from between the nutrients, vitamins and minerals (see Figures 2.3 (c) and 2.4 (c)).

2. Stimulus presentation time (3) a. short (1 second), b. medium (3 seconds), c. long (5 seconds).

3. Target location (see Figures 2.1 and 2.2) (3) a. serving information section (top), b. nutrient information section (middle), c. vitamin, mineral, footnote information (bottom).

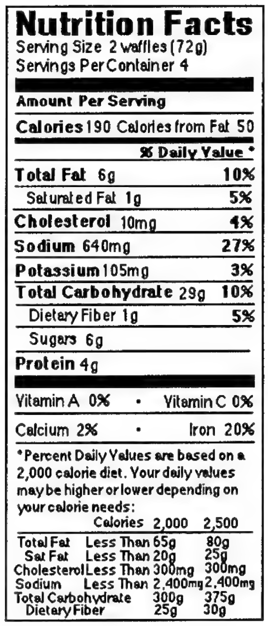
4. Information content of labels (2) a. high information content (large labels) (22 chunks constant information, 25 chunks variable information), b. low information content (small labels) (17 chunks constant information, 18 chunks variable information).

5. Label information reading and utilization experience (2) a. high, b. low.

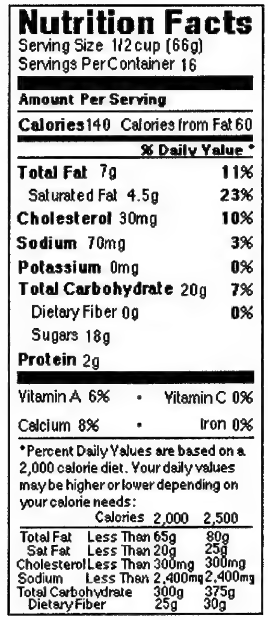
The two levels of experience in reading and utilization of nutrition labels was treated as a between-subjects factor. The experimental design provided a total of 180 trials per subject. All 180 trials for each subject were randomly ordered (see Table 2.5).

A session consisted of six blocks of 30 trials, with the session lasting approximately two hours and fifteen minutes. Subjects could request rest periods at any point in the testing but short rest periods were provided every thirty trials if not requested sooner. The eye tracker was calibrated to each subject before the testing began and after each rest period.

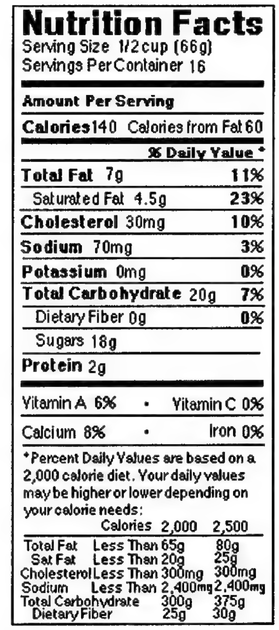
A factorial ANOVA was used to analyze the data for each of these conditions for all subjects. Subjects were nested within experience level and treated as a covariate. The general linear method was used for the analysis with all factors treated as fixed effects. No interactions higher than three-way were included in the model.



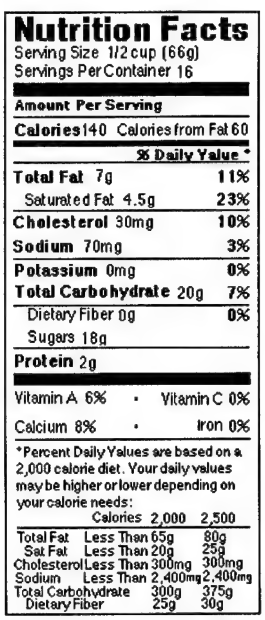
a). Full anchoring, full alignment lines (FA/FAL)



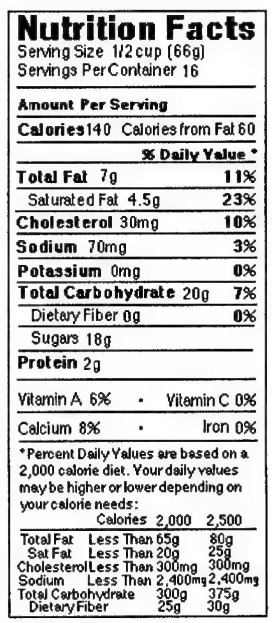
c). Full anchoring, no alignment lines (FA/NAL)



e). Partial anchoring, full alignment lines (PA/FAL)

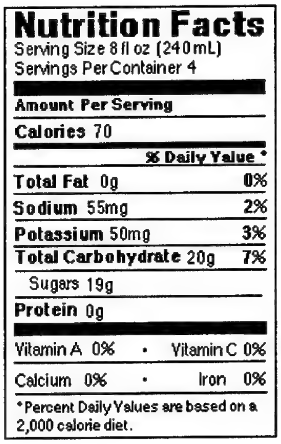


b). Full anchoring, partial alignment lines (FA/PAL)

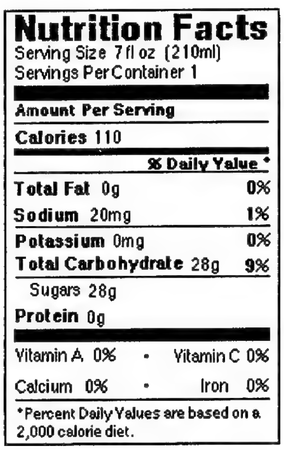


d). No anchoring, full alignment lines (NA/FAL)

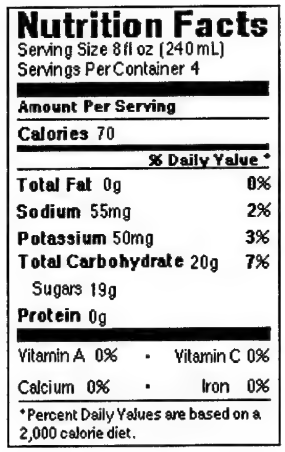
Figure 2.3. Samples of full-size stimuli (3/5 original size).



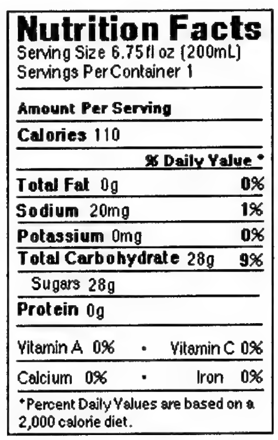
a). Full anchoring, full alignment lines (FA/FAL)



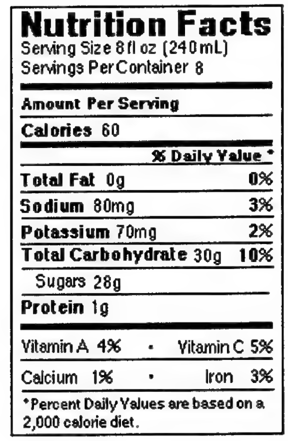
b). Full anchoring, partial alignment lines (FA/PAL)



c. Full anchoring, no alignment lines (FA/NAL)



d). No anchoring, full alignment lines (NA/FAL)



e). Partial anchoring, full alignment lines (PA/FAL)

Figure 2.4. Samples of simplified stimuli (3/5 original size).

Table 2.2. Within-subject experimental design. Number of trials indicated.

Condition		FullAnchoring/ FullAlignment Lines			Full Anchoring/ PartialAlignment Lines			FullAnchoring/ NoAlignment Lines			No Anchoring/ FullAlignment Lines			PartialAnchoring/ FullAlignment Lines			
Presentation times	Info Content	Top	Middle	Bottom	Top	Middle	Bottom	Top	Middle	Bottom	Top	Middle	Bottom	Top	Middle	Bottom	Tot
1 second	Large	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
	Small	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	60
3 seconds	Large	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
	Small	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	60
5 seconds	Large	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
	Small	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	60
Totals		36			36			36			36			36			180

Chapter 3

RESULTS

3.1. Fixation Determination

Prior to each trial, subjects were required to fixate at starting fixation points between 9.2 and 22 degrees distance, along the perimeter of the label, from the nutrition label target. Subjects thus had to move their eyes from the starting point to the label, fixate on different areas of the label for orientation, and make corrective movements until target capture or expiration of trial time.

An eye fixation was defined as a discrete glimpse lasting at least 100 msec between eye displacements. The cluster consisted of all x,y-coordinates that fell within a threshold of 3-degrees and lasted a minimum of 100 milliseconds (6 samples at 60 Hz) to determine the fixation as defined by Karsh and Breitenbach (1983). Eye fixations from the raw eye-movement data were determined by a position variance of data points method. The position variance was thresholded and all subsequent datapoints with a lower position variance than this threshold were considered to belong to a fixation (see Anliker, 1976). The fixation cluster threshold was raised or lowered as required until a satisfactory result was obtained due to subject variability similar to the variability encountered by Krose (1986). Between-subject differences required adjustment of plus or minus one-half degree in the maximum cluster dispersion in order to capture a sufficient number of fixation clusters. A minimum

of one fixation was required for a 1-second trial, 5 for a 3-second trial and 8 for a 5-second trial. Optimal dispersion angle was determined by analyzing all trials at a range of values from 2 to 4 degrees in 1/2-degree increments. A best-fit value of dispersion angle was determined through visual analysis of fixation determinations as well as characteristics of the numbers of fixations and fixation times. Low numbers of trial fixations with low fixation duration was a cause to increase the angle while low numbers of fixations with exceedingly high fixation times (e.g., >900 msec) was a cause for a reduction. This method produced 1789 (99 percent) analyzable trials. Of the 11 trials not producing any fixations, two were attributed to equipment error with the remainder being attributed to inter-trial changes; e.g., subjects exceeded the dispersion angle or did not fixate for the minimum time. One dispersion angle was selected per subject and all trials were analyzed at that angle.

3.2. Dependent Variables

The dependent variables were: (1) distance (in degrees) from initial capture fixation position to target (LD), (2) total number of fixations until initial capture (NF), (3) total time (msec) until initial target capture (including capture fixation time) (CT), (4) target search time (msec) (ST) and (5) initial capture fixation time (msec) (FT).

Distance from capture fixation mean position to target was determined by computing the distance from the mean x,y coordinate of the capture fixation to the x,y coordinate of the middle of the target. Capture fixation was the first fixation to have a mean x,y coordinate of that fixation cluster equal to or less than 2.5 degrees from mid-target. This measure was included to determine the furthest distance a subject could fixate from a

target and still capture it. Shorter distances could signal trial conditions where target discrimination was more difficult.

Total number of fixations until initial capture was the number of fixations made by subjects during the trials before landing within the target capture region. This response variable was measured to investigate whether expertise affected the number of fixations to target capture.

Time of target capture (including capture fixation time) consisted of the time from onset of image presentation up to and including the time of the capture fixation. This time includes the target search time and the cluster signifying a discrete eye stop (fixation) when the target, at that point, was within subject's UFOV. Times can signify difficulty of the task. As task difficulty increased, capture time would be expected to increase. Total capture time was made up of a target-search time component and a capture- fixation time component as shown in Figure 3.1.

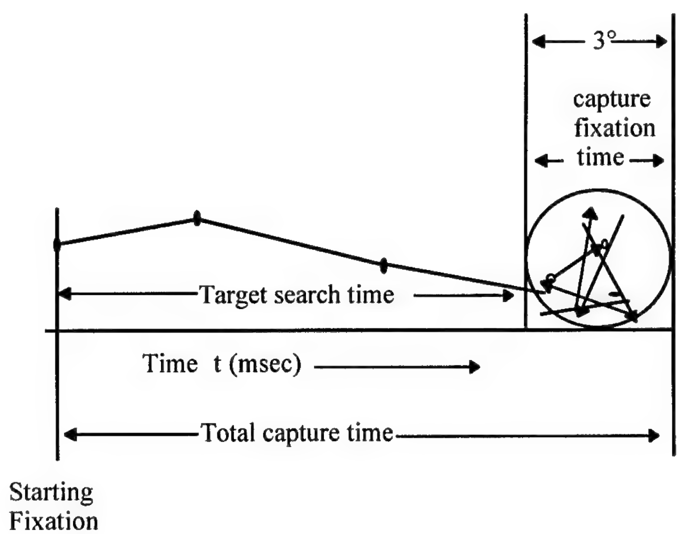


Figure 3.1. Total capture time and its components.

Capture fixation time was the mean ending time of the first fixation cluster whose mean position was within 2.5 degrees of the target. Subjects could be expected to accurately recognize half of the targets when a fixation landed 2.5 degrees away (Bouma, 1970). The shortest stimulus presentation time was 1 second. With random ordering of the trials, subjects had to assume each trial could last only one second with quick location of targets paramount. Sometime during the fixation cluster, subjects captured the target and selected a response. Significant time differences could signify different cognitive processes in the response formulation.

Target search time was determined from onset of stimulus presentation until just prior to the target capture fixation as calculated by the eye fixation algorithm. This response variable was used to determine if search time or capture fixation time was more influential on changes in total capture time.

3.3. Target Capture Conditions

Only trials answered correctly when the capture fixation fell within the capture range were analyzed. Capture of a target was the first fixation of a trial where the angle subtended from the centroid of a fixation to the middle of the target was less than or equal to 2.5 degrees. Correct trials that met the spatial threshold accounted for 1263 out of the 1800 total trials (70 percent). Table 3.1 shows how the trials were characterized across subjects. Appendix C contains number of correct responses by experience level.

Table 3.1. Across-subjects breakdown of trials into response and distance from target categories.

	Bad data	Capture Trials	Non-capture Trials	All
Correct trials	8	1263	311	1582 (88%)
Error trials	3	83	132	218 (12%)
Total trials				1800

Across all conditions, highly experienced subjects made more correct responses than less experienced subjects, with an average difference of 25 more trials meeting the analysis criteria (see Table 3.2). Ranges of correct responses for experience level were nearly identical with a range of 20 between conditions for the less experienced subjects (103 to 123) and 23 for the highly experienced subjects (129 to 152). The smallest difference between experience levels was for the NA/FAL condition where the highly experienced subjects recorded 17 more usable trials. FA/FAL condition had the highest total number of usable trials at 275 while the lowest number was 232 for the FA/PAL condition.

Table 3.2. Number of usable (correct-response and within-capture-range) trials by condition and experience level.

Condition	Low Experience	High Experience	Condition Totals
FA/FAL	123	152	275
FA/PAL	103	129	232
FA/NAL	110	137	247
NA/FAL	118	135	253
PA/FAL	115	141	256
Experience Totals	569	694	1263

Abbreviations: FA/FAL-Full anchoring/Full alignment lines
FA/PAL-Full anchoring/Partial alignment lines
FA/NAL-Full anchoring/No alignment lines
NA/FAL-No anchoring/Full alignment lines
PA/FAL-Partial anchoring/Full alignment line

3.4. ANOVA Summary

Results of the analysis of variance (ANOVA) across all dependent variables are summarized in Table 3.3. ANOVA tables for all five dependent variables are located in Appendix D. In the following sections each of these dependent variables will be discussed separately.

Table 3.3. Summary of results of analysis of variance.

	Dependent Variables				
Factors	LD	NF	CT	ST	FT`
Subject(experience)	NS	**	NS	*	*
Experience	NS	NS	NS	NS	NS
Condition	NS	*	***	**	NS
Info Content	NS	NS	NS	NS	NS
Presentation Time	NS	***	***	***	*
TargetLocation	NS	***	***	**	NS
Experience*Condition	NS	NS	NS	NS	NS
Experience*Info Content	NS	NS	NS	NS	NS
Experience*Presentation Time	NS	*	*	**	NS
Experience*Target Location	NS	NS	NS	NS	NS
Condition*Info Content	**	NS	**	*	NS
Condition*Presentation Time	NS	NS	NS	NS	NS
Condition*Target Location	NS	***	***	***	NS
Info Content*Presentation Time	NS	NS	NS	NS	NS
Info Content*Target Location	NS	NS	NS	NS	NS
Presentation Time*Target Location	NS	NS	NS	NS	NS
Experience*Condition*InfoContent	NS	NS	NS	NS	NS
Experience*Condition*Presentation Time	NS	NS	NS	NS	NS
Experience*Contition*Target Location	NS	NS	NS	NS	NS
Experience*InfoContent*Presentation Time	NS	NS	NS	NS	NS
Experience*InfoContent*Target Location	NS	NS	NS	NS	NS
Experience*Presentation Time*Target Location	NS	NS	NS	NS	*
Condition*InfoContent*Presentation Time	NS	NS	NS	NS	NS
Condition*InfoContent*Target Location	NS	***	***	***	NS
Condition*Presentation Time*Target Location	NS	NS	NS	NS	NS
Info Content*Presentation Time*Target Location	NS	NS	NS	NS	NS

Abbreviations:

LD-Distance from mean position of capture fixation to target (deg)
NF-Number of fixations to initial capture fixation
CT-Total capture time (msec)
ST-Target search time (msec)
FT-Time of initial capture fixation (msec)

*	- $p<0.05$
**	- $p<0.01$
***	- $p<0.001$
NS	- Not Significant

3.4.1. Landing Distance

On average, highly experienced subjects landed closer to targets during capture fixations, arrived quicker, and had longer capture fixations than less experienced subjects. No main effects were significant for landing distance but there was an interaction effect for condition and information content, $F(4, 1149) = 3.51, p<0.01$.

Across all conditions, highly experienced subjects fixated an average of 1.47 degrees from targets while less experienced subjects landed 1.64 degrees away. The range for highly experienced was 0.12 degrees with a minimum of 1.41 degrees for condition FA/PAL and a maximum of 1.53 for FA/FAL. Less experienced subjects exhibited a range of 0.15 degrees with a minimum of 1.59 degrees for FA/NAL and a maximum landing distance of 1.74 for the NA/FAL condition. Across experience level, the smallest difference was for the FA/FAL condition at 0.07 degree while the largest difference was for NA/FAL at 0.32 degree. Landing distances for information content, presentation times and target location were consistent across experience level with the difference ranging from 0.14 degrees to 0.19 degrees.

As shown in Table 3.4, subjects in both experience levels were able to land an average of 0.10 degrees closer to targets located at the bottom of the labels than in the other two target location conditions. Subjects with low experience landed closer to targets for 5-second stimulus presentation times while highly experienced subjects performed better for the 3-second presentation time. The same trend was exhibited when experience level is compared with label information content. Subjects in both experience levels were able to land closer to the targets in the low information content level with highly experienced subjects landing closer.

Table 3.4. Mean distance (degrees) from capture fixation mean position to target by condition, information content, presentation time and target location for experience level.

Condition	Low Experience	High Experience	Condition Mean
FA/FAL	1.60	1.53	1.56
FA/PAL	1.64	1.41	1.51
FA/NAL	1.59	1.47	1.52
NA/FAL	1.74	1.42	1.57
PA/FAL	1.61	1.49	1.55
Experience Mean	1.64	1.47	

Information Content	Low Experience	High Experience	Info Content Mean
High	1.67	1.48	1.56
Low	1.61	1.46	1.53

Presentation Time	Low Experience	High Experience	Present. Time Mean
1 sec	1.65	1.51	1.57
3 sec	1.65	1.44	1.54
5 sec	1.61	1.47	1.54

Target Location	Low Experience	High Experience	Targ. Loca. Mean
Top	1.66	1.51	1.58
Middle	1.66	1.50	1.58
Bottom	1.58	1.40	1.48

Abbreviations: FA/FAL-Full anchoring/Full alignment lines
FA/PAL-Full anchoring/Partial alignment lines
FA/NAL-Full anchoring/No alignment lines
NA/FAL-No anchoring/Full alignment lines
PA/FAL-Partial anchoring/Full alignment lines

Table 3.5 shows the mean landing distances in degrees from capture fixation position mean to target for condition and information content. The interaction was significant at $p<0.01$. There was a difference of 0.22 degrees across conditions for the high information content labels with a minimum of 1.43 degrees for FA/NAL and a maximum of 1.65 degrees for PA/FAL. The difference for the low information content labels was only 0.17 degrees with a minimum landing distance of 1.43 degrees for condition FA/PAL and maximum of 1.61 degrees for FA/NAL. Across information content, minimum difference existed for FA/FAL at 0.02 degrees with the largest difference of 0.21 degrees for PA/FAL. Three out of the five conditions had landing distances further from the targets in the high information content, FA/FAL (1.57 vs. 1.55 degrees), FA/PAL (1.60 vs. 1.43 degrees), and PA/FAL (1.65 vs. 1.44 degrees). However, two conditions, FA/NAL and NA/FAL, showed mean landing distances that were closer to the targets for the high information labels (1.43 vs. 1.61 degrees and 1.54 vs. 1.60 degrees respectively).

Table 3.5. Mean of distance (degrees) from capture fixation position mean to target for condition and information content of labels.

	Info Content		
Condition	High	Low	Mean
FA/FAL	1.57	1.55	1.56
FA/PAL	1.60	1.43	1.51
FA/NAL	1.43	1.61	1.52
NA/FAL	1.54	1.60	1.57
PA/FAL	1.65	1.44	1.55
Mean	1.56	1.53	1.54

Abbreviations: FA/FAL-Full anchoring/full alignment lines
FA/PAL-Full anchoring/partial alignment lines
FA/NAL-Full anchoring/no alignment lines
NA/FAL-No anchoring/full alignment lines
PA/FAL-Partial anchoring/full alignment lines

3.4.2. Number of Fixations to Capture

The following four main effects were significant for number of fixations to target capture (see Table 3.3): (1) Subject (experience) at $p < 0.01$, (2) Condition at $p < 0.05$, (3) Presentation Time at $p < 0.001$, and (4) Target Location at $p < 0.001$. Three interactions were also significant: (1) Experience * Presentation Time at $p < 0.05$, (2) Condition * Target Location at $p < 0.001$, and (3) Condition * Information Content * Target Location, $p < 0.001$

A strong, though not unexpected correlation of 0.842 existed between number of fixations to capture and capture time. Fixation duration averaged around 200 msec, therefore, as numbers of fixations increase, total capture times would also. For the covariate subjects (see Figure 3.2), mean numbers of fixations to capture varied from a low of 1.5 for Subject 3 to a high of 3.63 for Subject 10 ($F(2, 1149) = 5.43$, $p<0.01$) . A comparison of condition (see Figure 3.3), indicated that more fixations were required to capture the targets when alignment lines were varied (conditions FA/PAL and FA/NAL) than in the conditions with full alignment lines present ($F(4, 1149) =2.71$, $p<0.05$) . No trends were evident for conditions altering anchoring lines.

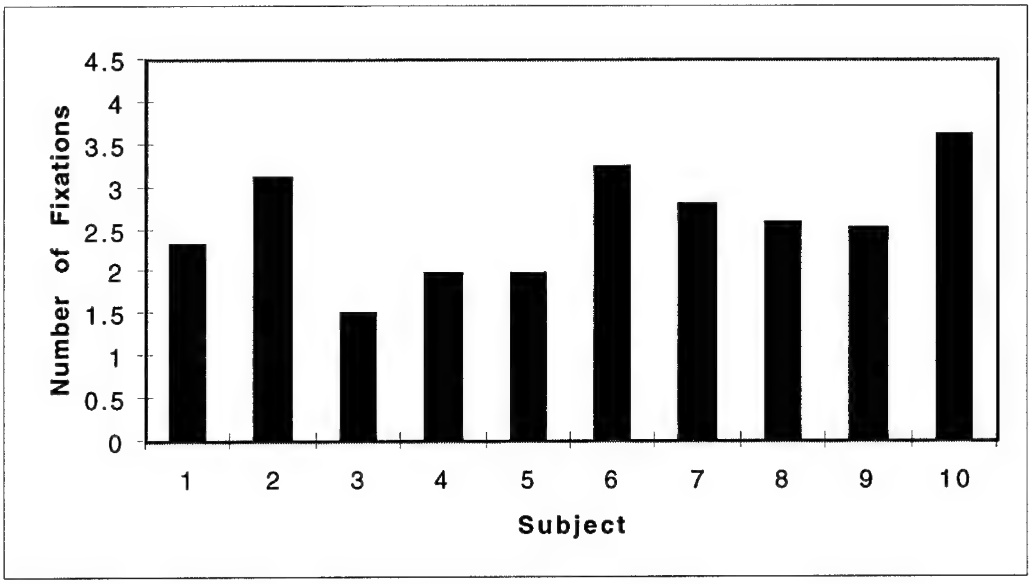
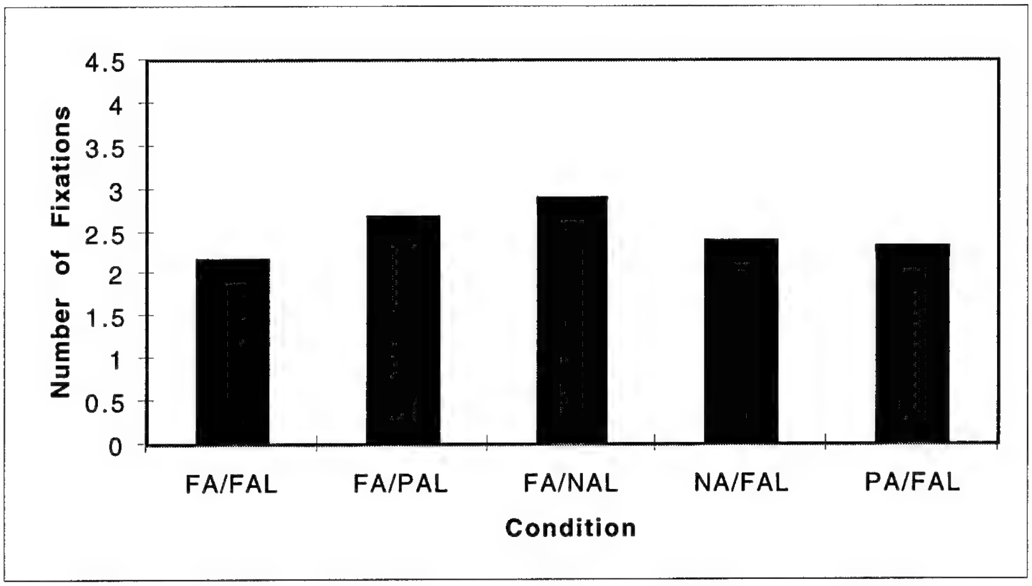


Figure 3.2. Average number of fixations to target capture by subject.

As presentation time increased, average number of fixations to capture also increased, a direct result of having more time to search for targets ($F(2, 1149) = 30.08$, $p< 0.001$, see Table 3.6). For the main effect of target location, targets positioned in the middle section required more fixations than at either the top or bottom locations ($F(2, 1149) = 10.39$, $p<0.001$). Targets located at the upper portion of the label averaged 2.14 fixations to capture, 2.33 fixations for bottom targets and 3.02 fixations for middle targets (see Table 3.6). Highly experienced subjects captured targets with an average of 2.14 fixations while less experienced subjects required an average of 2.90 fixations. This trend continued across all image conditions. Highly experienced subjects required least fixations for the NA/FAL condition (1.96) while less experienced subjects required least fixations to find targets in the FA/FAL condition (2.34). Across conditions, FA/FAL showed the lowest average number of fixations to capture targets (see Table 3.6).



Abbreviations:

FA/FAL-Full anchoring/full alignment lines
FA/PAL-Full anchoring/partial alignment lines
FA/NAL-Full anchoring/no alignment lines
NA/FAL-No anchoring/full alignment lines
PA/FAL-Partial anchoring/full alignment lines

Figure 3.3. Average number of fixations to target capture by condition.

The number of fixations to target capture showed an increase as presentation time increased for both experience levels. Average number of fixations to initial target capture were 2.11 fixations higher in the 5-second presentation time than in the 1-second presentation time for less experienced subjects. Highly experienced subjects' capture fixations with 5-second presentation times increased by 1.08 fixations from the 1-second average of 1.37 fixations (see Table 3.6). More fixations were required to capture targets located at the middle of labels than at the top or bottom. Less experienced subjects averaged 3.06 fixations to capture targets in labels with high information content and 2.77 fixations for labels with low information content. Highly experienced subjects were

consistent at both information content levels with 2.13 fixations for high information content labels and 2.15 fixations for the low level as shown in Table 3.6.

A comparison of the interaction between condition and target location showed the trend that both conditions with alignment line changes, FA/PAL and FA/NAL, required more fixations to capture targets than conditions with full alignment lines ($F(8,1149)=3.68$, $p<0.0001$, see Figure 3.4). The range of fixations to capture targets at the top of labels ranges from 1.94 for conditions FA/PAL and PA/FAL to a high of 2.53 for condition FA/NAL. Middle target locations exhibited a range from a low of 1.94 fixations for condition FA/FAL to a high of 4.25 for FA/NAL. Bottom target locations ranged from a low of 2.03 for the PA/FAL condition to a high of 2.90 for the FA/NAL. Table 3.7 shows the mean number of capture fixations for the three-way interaction between condition, target location and information content of labels ($F(8,1149)=4.42$, $p<0.001$). The overall trend shows that more fixations were required to locate targets on high information content labels than low. The trend reversed for targets at the top location for conditions FA/NAL, where the low information content label required more fixations to capture than the high information content labels (2.78 vs. 2.31 respectively). Condition PA/FAL also had this result with 2.00 fixations for low information content label vs. 1.89 fixations for the high information content variety. Middle location targets had one condition (PA/FAL) that showed this reversal with an average of 4.46 fixations to locate targets on the low information content labels vs. 2.09 fixations on the high information content labels. Bottom target locations also had one condition that reversed the expected results. The low information content label of condition FA/NAL had an average of 2.49 fixations to capture while the larger labels only needed an average 1.91 fixations.

Table 3.6. Number of fixations to initial target capture for condition.

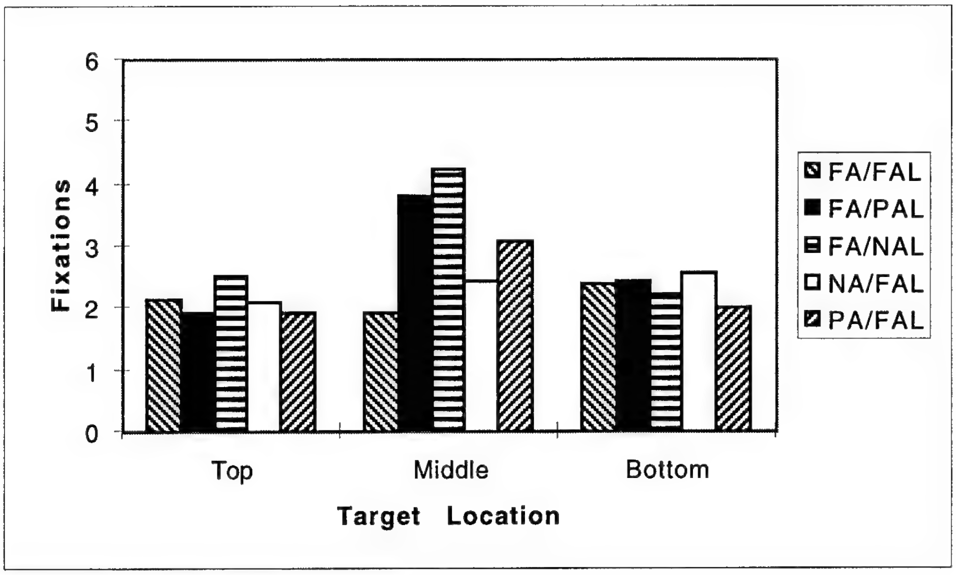
Condition	Low Experience	High Experience	Condition Mean
FA/FAL	2.34	2.03	2.17
FA/PAL	3.25	2.20	2.67
FA/NAL	3.38	2.52	2.90
NA/FAL	2.87	1.96	2.38
PA/FAL	2.76	2.00	2.34
Experience Mean	2.90	2.14	

Information Content	Low Experience	High Experience	Info Content Mean
High	3.06	2.13	2.53
Low	2.77	2.15	2.44

Presentation Time	Low Experience	High Experience	Present. Time Mean
1 sec	1.42	1.37	1.39
3 sec	2.84	2.28	2.54
5 sec	3.53	2.45	2.96

Target Location	Low Experience	High Experience	Targ. Loca. Mean
Top	2.35	1.95	2.14
Middle	3.71	2.44	3.02
Bottom	2.69	2.05	2.33

Abbreviations:
FA/FAL-Full anchoring/full alignment lines
FA/PAL-Full anchoring/partial alignment lines
FA/NAL-Full anchoring/no alignment lines
NA/FAL-No anchoring/full alignment lines
PA/FAL-Partial anchoring/full alignment lines



Abbreviations: FA/FAL-Full anchoring/full alignment lines
FA/PAL-Full anchoring/partial alignment lines
FA/NAL-Full anchoring/no alignment lines
NA/FAL-No anchoring/full alignment lines
PA/FAL-Partial anchoring/full alignment lines

Figure 3.4. Average number of fixations to target capture by target location and condition.

Table 3.7. Mean number of fixations to capture targets for condition, information content of labels and target location.

	Info Content		
Condition	High	Low	Mean
FA/FAL	2.28	2.04	2.15
FA/PAL	2.07	1.81	1.94
FA/NAL	2.31	2.78	2.53
NA/FAL	2.26	1.98	2.18
PA/FAL	1.89	2.00	1.94
Mean	2.16	2.11	2.13

a) Top target location

	Info Content		
Condition	High	Low	Mean
FA/FAL	2.23	1.69	1.94
FA/PAL	4.20	3.50	3.80
FA/NAL	5.66	3.27	4.26
NA/FAL	2.75	2.25	2.46
PA/FAL	2.09	4.46	3.10
Mean	3.15	2.92	3.02

b) Middle target location

	Info Content		
Condition	High	Low	Mean
FA/FAL	2.46	2.36	2.40
FA/PAL	2.72	2.24	2.44
FA/NAL	1.91	2.49	2.22
NA/FAL	2.65	2.49	2.57
PA/FAL	2.21	1.88	2.03
Mean	2.37	2.29	2.32

c) Bottom target location

Abbreviations: FA/FAL-Full anchoring/full alignment lines
FA/PAL-Full anchoring/partial alignment lines
FA/NAL-Full anchoring/no alignment lines
NA/FAL-No anchoring/full alignment lines
PA/FAL-Partial anchoring/full alignment lines

3.4.3. Capture Time

In a comparison of capture times across subjects, mean capture times were slowest for two conditions that varied alignment lines (FA/PAL at 1025 msec and FA/NAL at 1107 msec) suggesting that alignment lines are important aids in locating targets on nutrition labels. ANOVA results confirm a main effect for condition ($F(4, 1149) = 4.77$, $p<0.001$). The three conditions with full alignment lines but various anchoring levels show slightly quicker capture speed as anchor lines are thinned. This trend, although not significant, suggested that varying anchoring line thickness made locating targets more difficult (see Table 3.8).

Capture times increased as presentation time increased ($F(2, 1149) = 40.81$, $p<0.001$). The mean capture time of 534 msec for the 1-second presentation increased by 76 percent (534 msec to 938 msec) when the presentation time increased to 3 seconds. A further increase of 20 percent was recorded as presentation times were increased to 5 seconds (mean capture time of 1122 msec). More correct responses were made as presentation times increased so additional search time would lead to more corrective saccades during target search strategies (see Appendices C.1 and C.2).

Minimum capture time for the main effect of target location were recorded for the top target location (844 msec) with bottom location targets only slightly higher at 876 msec ($F(2, 1149) = 7.41$, $p<0.001$). Middle target location had a mean capture time of 1090 msec. This could be partly explained by the increase in the number of possible targets in the middle location (10 as opposed to 4 each in the top and bottom locations) and

Table 3.8. Total capture time (msec) for condition, information content, presentation time and target location by experience level.

Condition	Low Experience	High Experience	Condition Mean
FA/FAL	1024	757	876
FA/PAL	1221	868	1025
FA/NAL	1286	964	1107
NA/FAL	977	694	826
PA/FAL	973	744	847
Experience Mean	1090	804	

Information Content	Low Experience	High Experience	Info Content Mean
High	1136	789	941
Low	1050	818	925

Presentation Time	Low Experience	High Experience	Present. Time Mean
1 sec	550	524	534
3 sec	1062	830	938
5 sec	1325	940	1122

Target Location	Low Experience	High Experience	Targ. Loca. Mean
Top	954	749	844
Middle	1310	905	1090
Bottom	1019	766	876

Abbreviations:

PA/FAL-Partial anchoring/Full alignment lines
NA/FAL-No anchoring/Full alignment lines
FA/NAL-Full anchoring/No alignment lines
FA/PAL-Full anchoring/Partial alignment lines
FA/FAL-Full anchoring/Full alignment lines

partly by the additional search required to answer questions that utilized percent daily value quantities which were physically separated from their identifying title.

The experience level vs. presentation time interaction was significant ($F(2, 1149) = 4.45$, $p<0.05$). The less experienced subjects averaged 550 msec per target capture while highly experienced subjects averaged 524 msec (see Figure 3.5). As presentation times increased from 1 to 3 seconds, less experienced subjects capture times increased by 93 percent (from 550 msec to 1062 msec) in contrast to a 58 percent increase (524 to 830 msec) exhibited by the highly experienced subjects. Stimulus presentation times of 5 seconds resulted in a 25 percent further increase in capture time for less experienced subjects (1062 to 1325 msec) while the highly experienced group only resulted in a 13 percent increase from the 3-second to the 5-second presentation times (938 to 1122 msec).

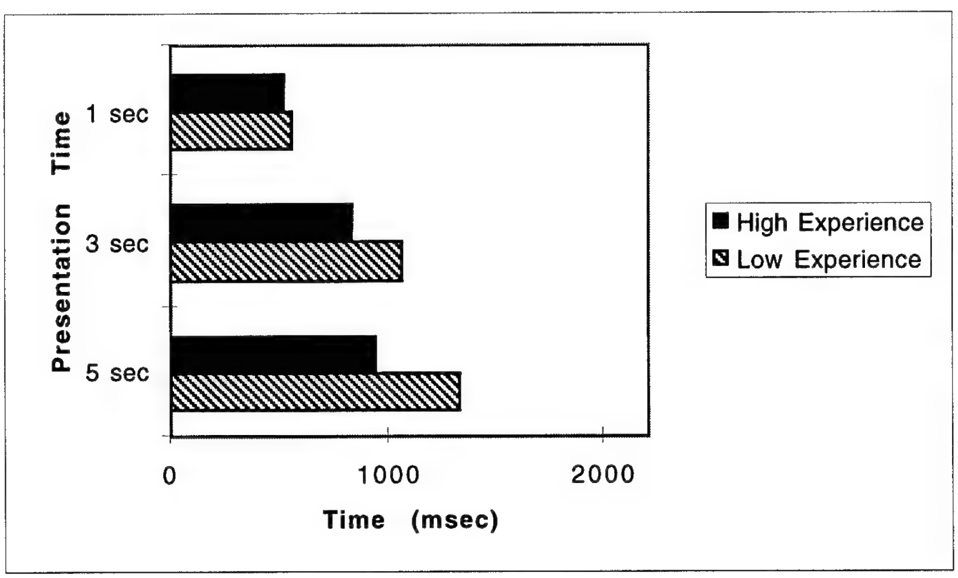
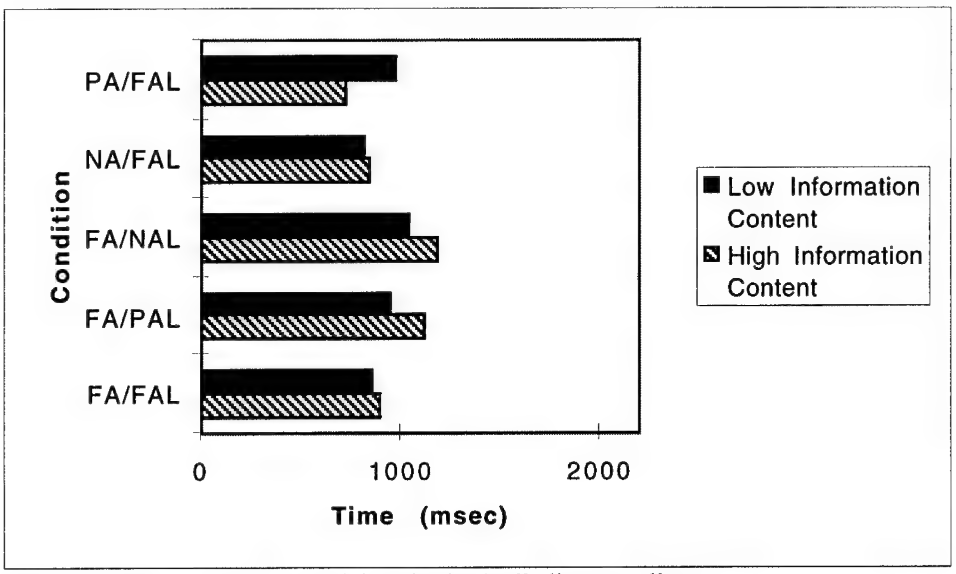


Figure 3.5. Capture time by stimulus presentation time and experience level.

Comparing the interaction of capture time by condition for label information content in Figure 3.6 exhibits a consistent trend of shorter capture times for small labels in all conditions except for the PA/FAL condition where the trend is reversed ($F(4, 1149) = 3.63$, $p<0.01$). In this condition, the small label had a mean capture time 249 msec longer than large labels. This occurred despite the fact that the PA/FAL high information content stimulus actually recorded the shortest capture times of all conditions and information content.

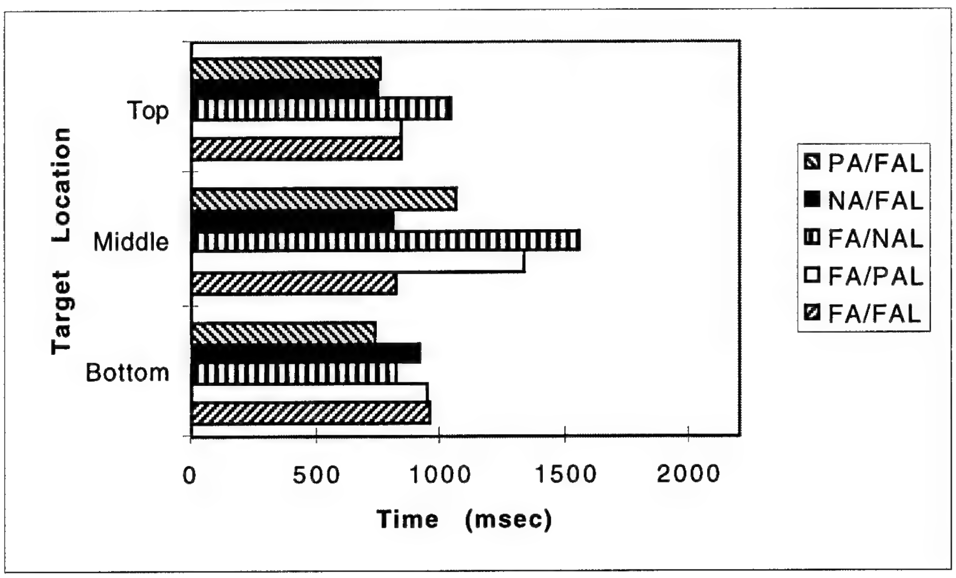


Abbreviations: PA/FAL-Partial anchoring/Full alignment lines
NA/FAL-No anchoring/Full alignment lines
FA/NAL-Full anchoring/No alignment lines
FA/PAL-Full anchoring/Partial alignment lines
FA/FAL-Full anchoring/Full alignment lines

Figure 3.6. Capture time by condition and label information content.

For the interaction of condition and target location, FA/NAL exhibited the slowest capture times for top (1047 msec) and middle (1561 msec) target locations, while the slowest time for bottom location targets was 963 msec for condition FA/FAL ($F(8, 1149) =$

3.95, p<0.001, see Figure 3.7). The condition with no alignment lines (FA/NAL) apparently influenced target capture times even though the top section of the labels were the same for FA/PAL and FA/NAL. It is possible that the lack of the alignment lines caused subjects to slow their movement to the top of the label. Middle target conditions clearly showed that the removal of any alignment lines hindered target capture. The partial alignment line condition (FA/PAL) had mean capture time of 1338 msec while no alignment lines (FA/NAL) had capture times averaging 1561 msec. Bottom target locations did not exhibit any large changes in capture time but were shortest for the partial anchoring, full alignment condition (PA/FAL) at 738 msec.



Abbreviations: PA/FAL-Partial anchoring/Full alignment lines
NA/FAL-No anchoring/Full alignment lines
FA/NAL-Full anchoring/No alignment lines
FA/PAL-Full anchoring/Partial alignment lines
FA/FAL-Full anchoring/Full alignment lines

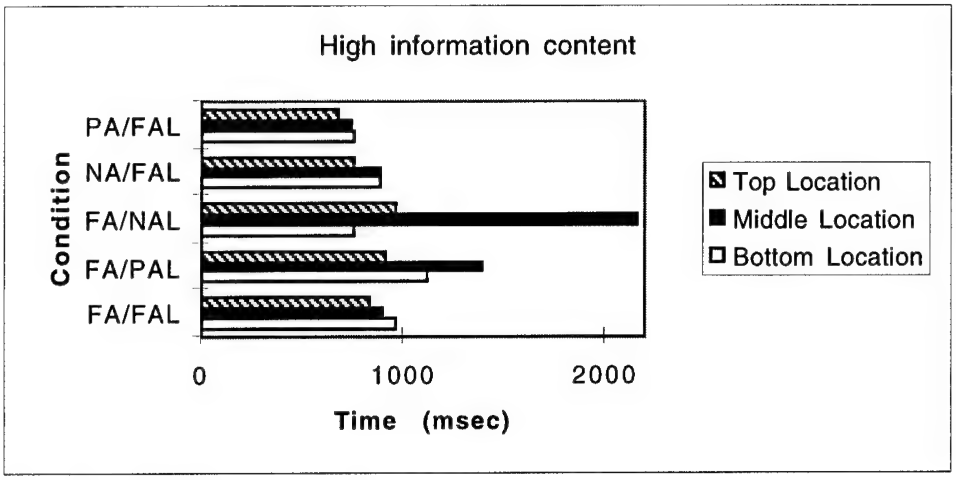
Figure 3.7. Capture time by target location and stimulus condition.

A comparison of the three-way interaction for condition, information content and target location (F(8, 1149) = 5.65, p<0.001) revealed some surprising results (see Figure

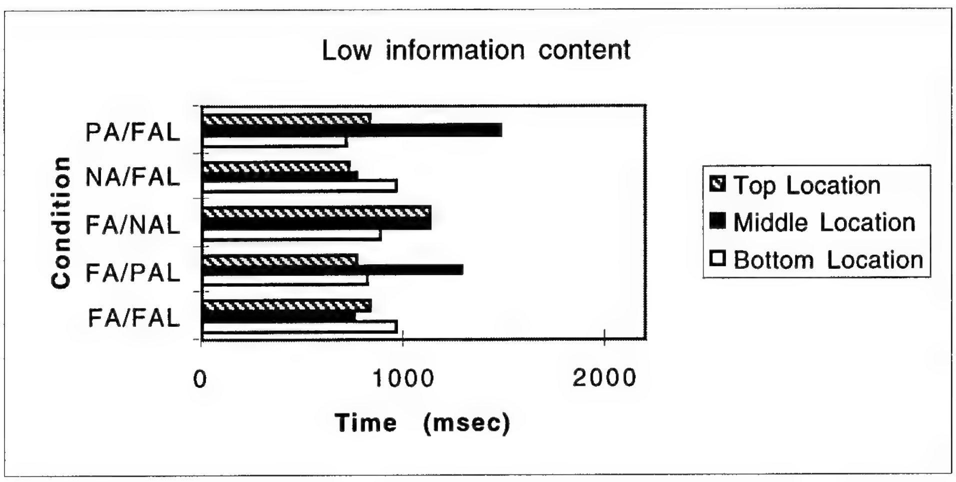
3.8). High information content labels contained more distractors from among which to locate the targets. Theoretically, capture times for large labels should be higher than for the small labels. As Figure 3.8 clearly shows, that did not hold for all conditions and label sizes for target locations. This held for middle target locations for all conditions except PA/FAL where small labels took twice the time to capture targets than large labels (1488 msec vs. 742).

The condition FA/FAL had with nearly identical, although not quickest capture times. Top targets showed capture times of 837 msec for large labels vs. 838 for small and for bottom targets times were 959 msec large and 967 small. Major differences are realized primarily in the middle target range. Maximum capture time for this interactions was exhibited by the high information content, FA/NAL condition at 2164 msec. In a comparison of top target locations, high information content labels, FA/NAL had the longest capture time of 961 msec while PA/FAL had the shortest at 683 msec. For the same target location but low information content, condition FA/NAL had longer capture times. The two lowest average capture times were found for the NA/FAL and PA/FAL conditions (see Table 3.8). The capture time for FA/FAL was also at least 149 msec faster by than the two conditions that varied the number of alignment lines (FA/PAL and FA/NAL).

Across all conditions, subjects with high experience were able to make initial capture of the target faster than those with less experience in both large and small labels sizes. An interaction was evident for condition five, PA/FAL where total capture time for small labels exceeded total capture time for large labels for both experience levels.



a). Large label results



b). Small label results

Abbreviations: PA/FAL-Partial anchoring/Full alignment lines
NA/FAL-No anchoring/Full alignment lines
FA/NAL-Full anchoring/No alignment lines
FA/PAL-Full anchoring/Partial alignment lines
FA/FAL-Full anchoring/Full alignment lines

Figure 3.8. Capture time by condition, information content, and target location.

3.4.4. Search Time

Search time was highly correlated with capture time (.967) , as described by: Capture time = 225 + 1.01 (Search Time). The y-intercept here is the mean capture fixation time.

The following main effects were significant (see Table 3.3): (1) Subject (experience) at $p< 0.05$, (2) Condition at $p< 0.01$, (3) Presentation Time at $p< 0.001$, and (4) Target Location at $p< 0.01$. The following four interactions were also significant: (1) Experience * Presentation Time at $p< 0.01$, (2) Condition * Information Content at $p< 0.05$, (3) Condition * Target Location at $p< 0.001$, and (4) Condition * Info Content * Target Location at $p< 0.001$.

Less experienced subjects averaged 321 msec longer to locate targets than the highly experienced subjects (879 vs. 558 msec, see Table 3.8). Across conditions, FA/PAL and FA/NAL had search times of 806 msec and 849 msec respectively while the remaining three conditions, FA/FAL, NA/FAL, and PA/FAL had mean search times of 641, 612 and 623 msec respectively. The trend suggested that alignment lines played an important role in the location of targets while changes in anchoring lines had no effect on the target search. There was a difference of 249 msec between the minimum and maximum search times for less experienced subjects. The condition with minimum time was PA/FAL at 785 msec while FA/NAL had the maximum search time of 1034 msec. A nearly equal range existed for the highly experienced subjects. The difference between the high and low search times was 240 msec with the minimum time of 460 msec for condition NA/FAL and maximum time of 700 msec for FA/NAL. Search time increased as presentation time

increased. As in capture time results, this was due to having more time in which to search for targets.

Analysis of information content showed that less experienced subjects found targets 58 msec quicker on the low information label than the high information labels. Highly experienced subjects search time was nearly the same for both information content labels. There was an increase of only 11 msec but the increase was for the low information stimulus. The gap across experience level was greatest for high information content at 368 msec as it took less experienced subjects an average of 910 msec to locate targets and 552 msec for the highly experienced group. The gap for low information content stimuli was 289 msec (852 msec for less experienced vs. 563 msec for high, see Table 3.9).

As presentation time increased, search times increased. Across all subjects, times increased from 334 msec for 1-second presentations to 709 msec for 3-second presentation and 876 msec for 5-second presentation times. The increase was greatest for the less experienced subjects who ranged from a low of 361 msec to a high of 1096 msec (difference of 735 msec). In contrast, the highly experienced subject times increased less than half that of their less experienced counterparts as the range went from 317 msec at 1 second to 678 msec at 5 seconds (difference of 361 msec).

Middle target locations caused subjects at both experience levels to require more time to find targets than at the top or bottom. Across all subjects, top targets required only 629 msec to be located, bottom targets required 653 msec and middle targets required 835 msec. This was partly due to the increase in the number of possible targets in the middle location as compared to each of the other two locations (10 vs. 4 possible targets per location). The layout of the middle location also may have contributed to an increase in times. In the top and bottom location, targets are directly to the right of the label. In the

middle location, targets could either be directly to the right, if the question pertained to how much of the item was in the food, or along the right edge of the stimulus, if the question pertained to the percent daily value of the nutrient.

Search time was significant for subject ($F(2, 1149) = 3.07$, $p < 0.05$). Subject 3 (high experience level), recorded shortest mean search times (291 msec, see Figure 3.9). Longest search time of 1159 msec was exhibited by subject 10. Analysis of search times showed that subjects with shorter search times had more trials meeting the analysis criteria.

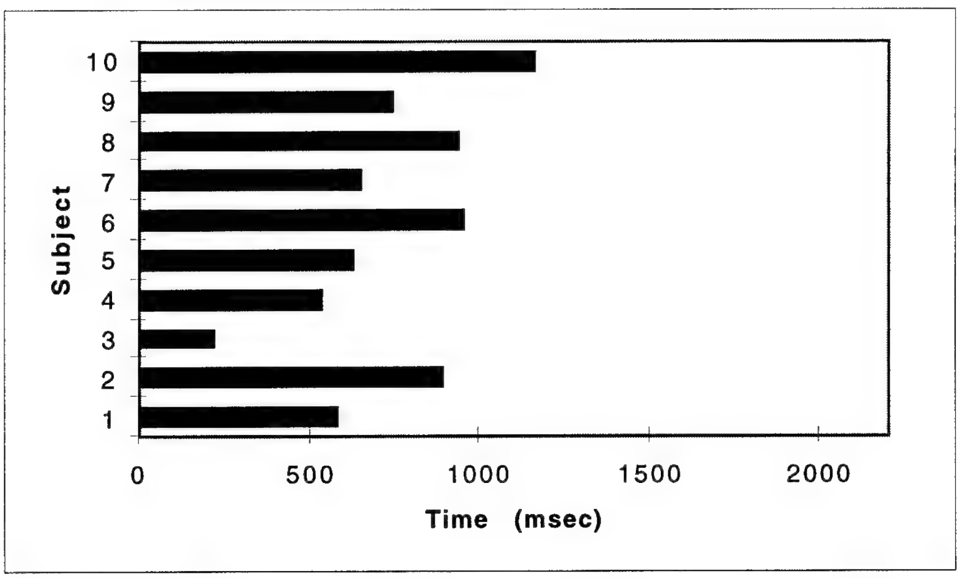


Figure 3.9. Target search time by subject.

Table 3.9. Search time (msec) mean values for condition, information content, stimulus presentation time and target location by subject experience level.

Condition	Low Experience	High Experience	Condition Mean
FA/FAL	792	518	641
FA/PAL	1028	628	806
FA/NAL	1034	700	849
NA/FAL	786	460	612
PA/FAL	785	490	623
Experience Mean	879	558	

Information Content	Low Experience	High Experience	Info Content Mean
High	910	552	709
Low	852	563	696

Presentation Time	Low Experience	High Experience	Present. Time Mean
1 sec	361	317	334
3 sec	861	576	709
5 sec	1096	678	876

Target Location	Low Experience	High Experience	Targ. Loca. Mean
Top	761	515	629
Middle	1063	645	835
Bottom	825	521	653

Abbreviations: FA/FAL-Full anchoring/full alignment lines
FA/PAL-Full anchoring/partial alignment lines
FA/NAL-Full anchoring/no alignment lines
NA/FAL-No anchoring/full alignment lines
PA/FAL-Partial anchoring/full alignment lines

Target search time followed a trend where the high information labels required more time in all conditions except condition PA/FAL, where the smaller label took subjects 741 msec to locate targets and 513 msec for targets on large labels (see Figure 3.10).

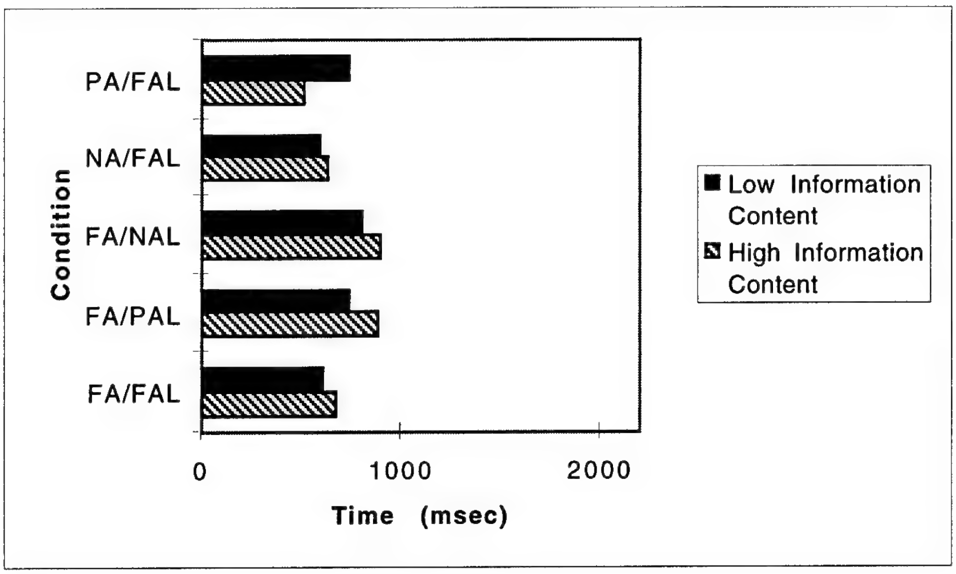


Figure 3.10. Target search time by stimulus condition and label information content.

A comparison of condition and target location in Figure 3.11 shows a trend that middle location targets in conditions FA/PAL, FA/NAL, and PA/FAL required more time to locate targets while conditions FA/FAL and NA/FAL had shorter search times than some of the other target locations in the same condition. In condition FA/FAL, average search time for the condition was 641 msec. Broken down into target location, search time was lowest of the three target locations at 569 msec while top locations averaged 611 msec per search and bottom targets had 736 msec average search times. Condition NA/FAL, with the lowest average search time of all conditions at 612 msec, had a 558 msec search time

for targets at the top of the target, 602 msec for targets in the middle location and 678 msec for bottom targets. Another trend evident was that, whereas the top targets traditionally have the shortest search times, condition FA/NAL exhibited the longest for all conditions at 801 msec. The next closest search time was 158 msec while the other four conditions exhibited a range of only 109 msec between them. Middle target search times ranged from a low of 602 msec for condition NA/FAL to a high of 1256 msec for condition FA/NAL. Bottom targets were more in line with times of the top target locations. The search times ranged from a minimum of 541 msec in condition PA/FAL to a high of 736 msec in condition FA/FAL. A further comparison of search times is shown in Figure 3.12. The overall longest search time was for condition FA/NAL, high information content, middle target location at 1749 msec for large labels, mi, top target location was 732 msec in condition FA/NAL.

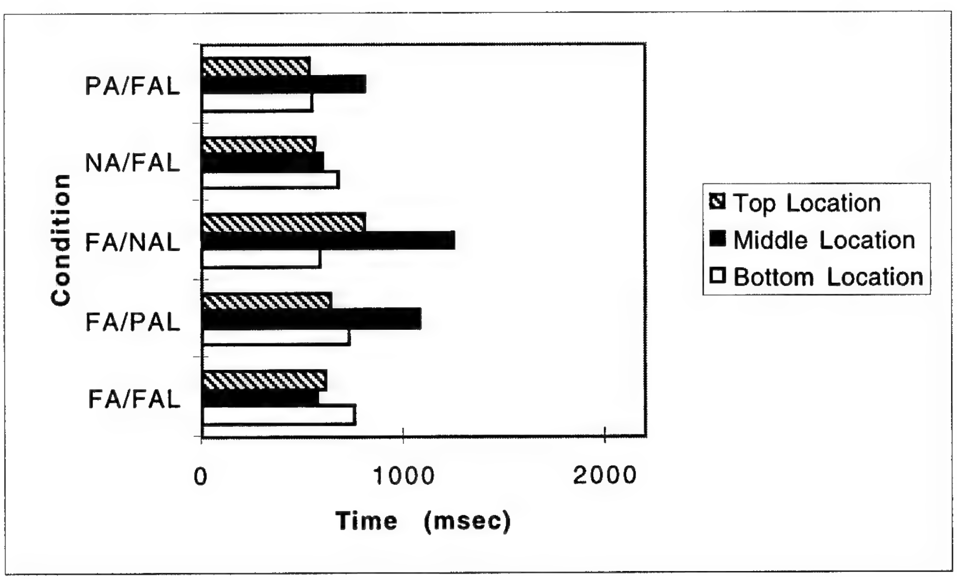
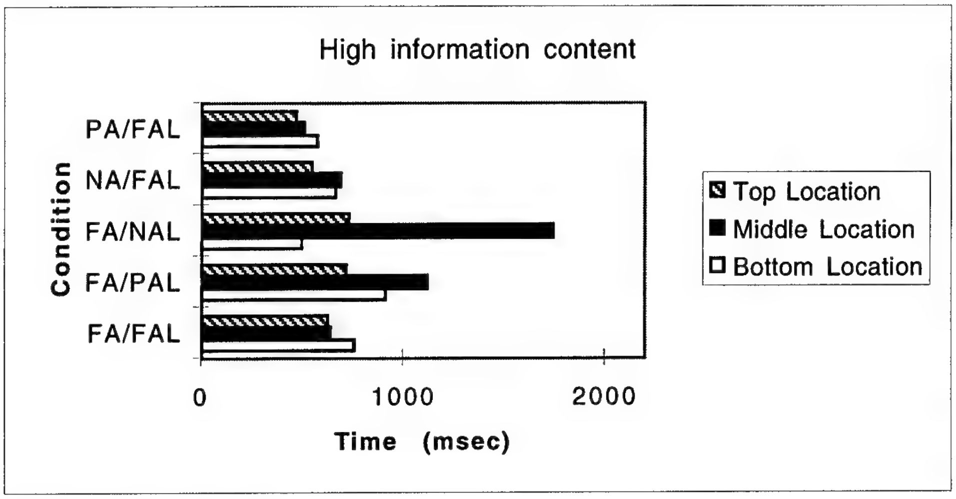
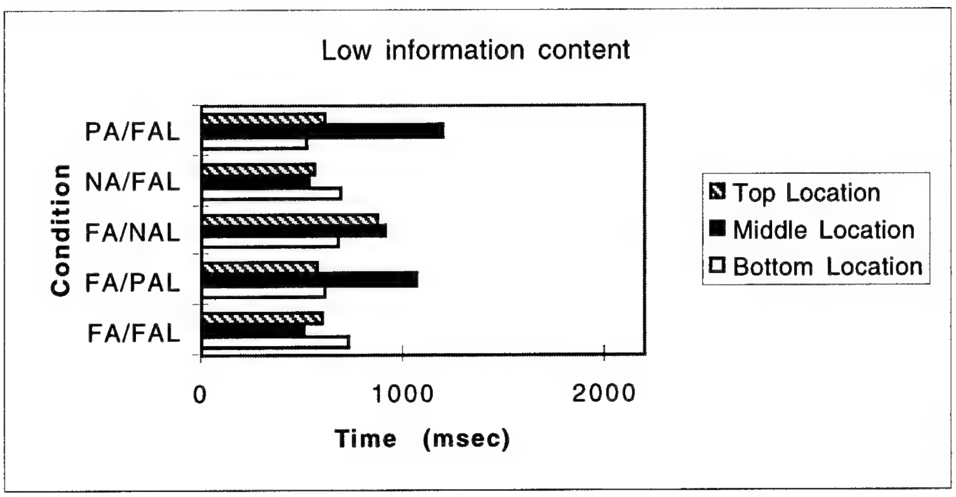


Figure 3.11. Target search time by condition and target location.



a). Large label results



b). Small label results

Abbreviations: FA/FAL-Full anchoring/full alignment lines
FA/PAL-Full anchoring/partial alignment lines
FA/NAL-Full anchoring/no alignment lines
NA/FAL-No anchoring/full alignment lines
PA/FAL-Partial anchoring/full alignment lines

Figure 3.12. Target search time by condition, target location, and label information content.

3.4.5. Capture Fixation Time

Significant results were found for the following (see Table 3.3): (1) Subject (experience) at $p< 0.05$, (2) Presentation Time at $p< 0.05$, and (3) Experience * Presentation Time * Target Location at $p< 0.05$.

Highly experienced subjects recorded initial capture fixation times that averaged 35 msec longer than less experienced subjects, 246 msec to 211 msec respectively (see Table 3.10). The smallest gap between experience level was in the FA/FAL condition (8 msec) followed by FA/NAL (12 msec), NA/FAL (44 msec), FA/PAL (47 msec), and PA/FAL (67 msec). The shortest capture fixation times were for conditions NA/FAL and FA/PAL (average of 214 and 219 msec, respectively) while the longest fixation times were recorded for condition FA/NAL with an average capture fixation that lasted 259 msec. Information content produced different capture fixation time effects for the experience levels as shown in Table 3.10. Capture fixation times dropped from the high information content labels to the low content labels for the less experienced subjects (226 to 198 msec respectively) but the trend reversed for the highly experienced subjects as capture fixation times increased as labels size decreased (237 to 255 msec).

Presentation time affected highly experienced subjects more. Capture fixations were 207 msec with a 1-second presentation time and increased to an average 262 msec with a 5-second presentation. Less experienced subjects had a smaller increase, going from 189 msec at 1-second to 229 msec at 5-seconds. Target location affected times of capture fixations as well. Middle targets had higher average fixation times and highly experienced subjects generated higher fixation times than less experienced subject (see Table 3.10). A main effect for subjects ($F(2, 1149) = 3.42$, $p< 0.05$) and

presentation time (F(2, 1149) = 3.31, p< 0.05) were present for initial capture time. Between-subject variability rather than experience level was responsible for time variability in capture fixations. Capture fixation times ranged from a low of 494 msec for subject 3 to a high of 1329 msec for subject 10 (see Figure 3.13)

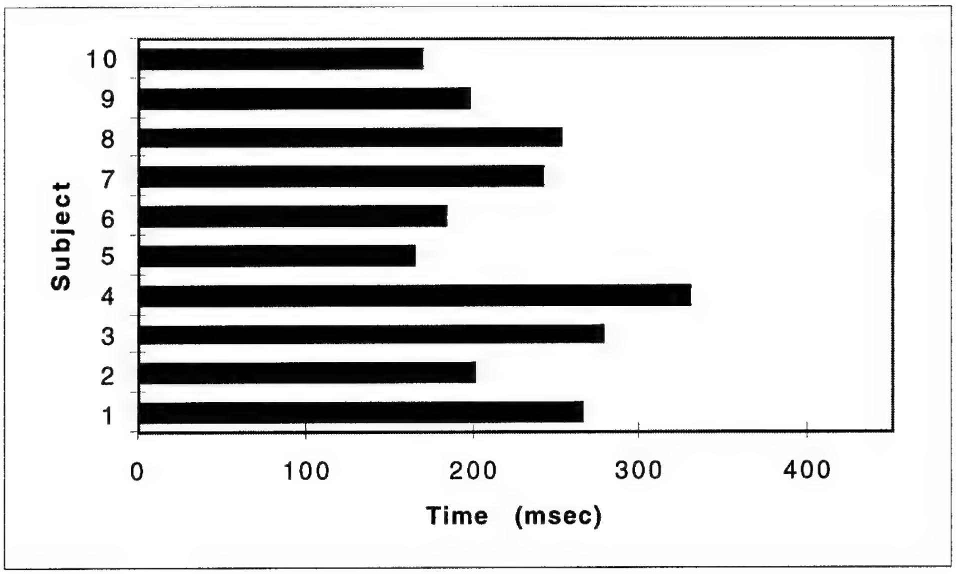


Figure 3.13. Mean capture fixation time by subject.

Experience does show up in a significant interaction with presentation time and target location (F[4, 1149] = 2.75, p< 0.05). A comparison of Figure 3.14 revealed that highly experienced subjects had longer fixation times across every target location and presentation time except one. Middle targets presented for five seconds resulted in mean capture fixation times of 287 msec for less experienced label readers and 258 msec for more experienced subjects.

Table 3.10. Time (msec) of capture fixation for experience level and condition.

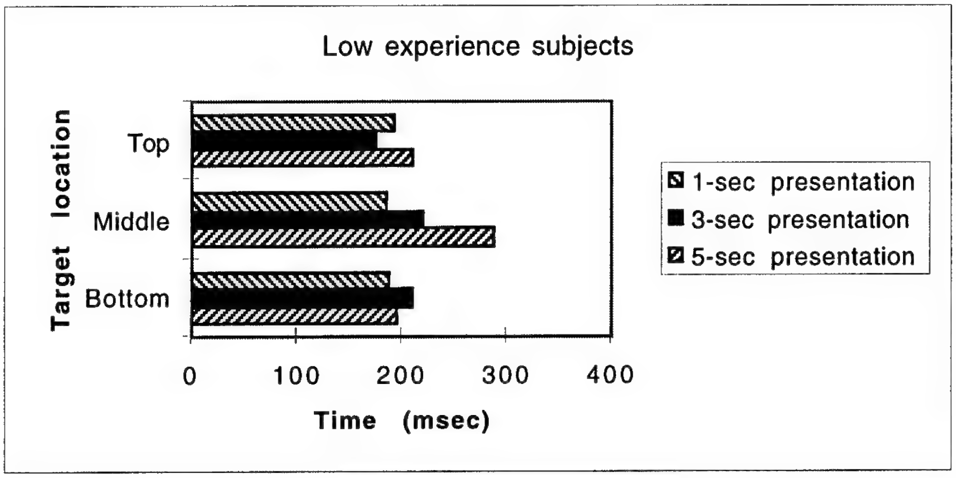
Condition	Low Experience	High Experience	Condition Mean
FA/FAL	231	239	236
FA/PAL	193	240	219
FA/NAL	252	264	259
NA/FAL	190	234	214
PA/FAL	187	254	224
Experience Mean	211	246	

Information Content	Low Experience	High Experience	Info Content Mean
High	226	237	232
Low	198	255	229

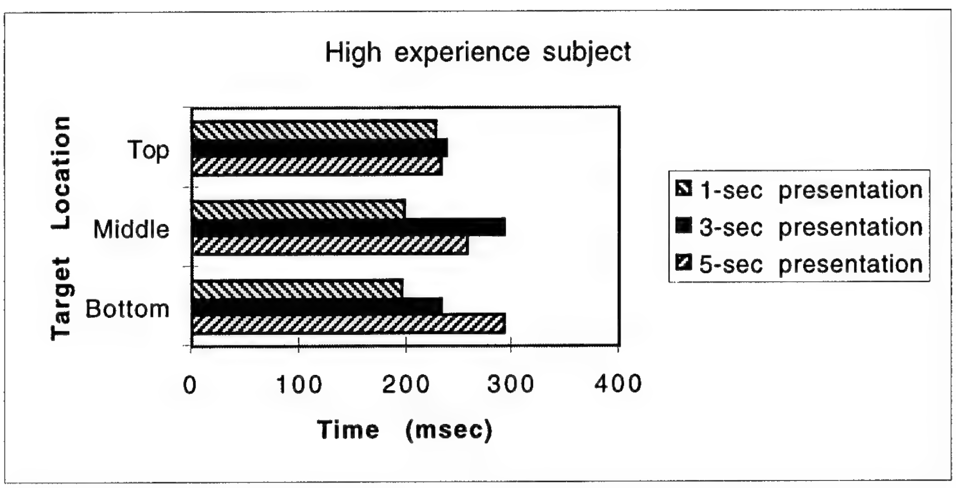
Presentation Time	Low Experience	High Experience	Present. Time Mean
1 sec	189	207	200
3 sec	201	254	229
5 sec	229	262	246

Target Location	Low Experience	High Experience	Targ. Loca. Mean
Top	193	234	215
Middle	248	260	255
Bottom	195	245	223

Abbreviations: FA/FAL-Full anchoring/full alignment lines
FA/PAL-Full anchoring/partial alignment lines
FA/NAL-Full anchoring/no alignment lines
NA/FAL-No anchoring/full alignment lines
PA/FAL-Partial anchoring/full alignment lines



a) Less experienced subject results



b) Highly experienced subject results

Figure 3.14. Mean capture fixation time by target location, presentation time, and experience level.

Chapter 4

DISCUSSION

4.1. General

This research was aimed at determining a baseline model of consumer reading strategies of nutrition labels through the use of eye tracking data. The current study validated, for the label variables tested, the prevailing nutrition label design as one where information can be located easily, regardless of experience level. Overall, any changes to the standard label design affected both experience level groups about equally.

This research also has implications beyond the nutrition label realm. Warning instructions can utilize some of the findings to enhance their readability. Instructions that must be followed in the correct order and with the correct values can implement some of the findings in attaining those results. One way of improving warnings is by including alignment lines. This research begins to answer the question posed by Laughery et al. (1993) about the interactivity of salient features when multiple salient features are utilized as well. There appears to be a possible interaction between the thickness of the ruled lines and the selective bold highlighting of nutrition information. For conditions that varied anchor line thickness, average capture times were fastest in the no anchor condition, slightly longer in the partial anchor condition and slowest for the full anchor condition.

Overall, the control condition of FA/FAL had the highest number of correct responses of all five conditions. The times were also among the most consistent for

capture times in all areas of the label, further evidence that the control condition was the easiest to search for information under time constraints.

4.2. Anchor and Alignment Lines

Tufte's (1983) premise on reduction of redundant data ink in graphs does not lend itself to information presented in tabular form such as nutrition labels: any reduction in alignment lines caused significant increases in search and capture times. What was found, however, was that full alignment lines aided subjects in quickly locating targets that were separated from their identifying nomenclature by open space.

Anchor lines did not play a positive role in search strategies as some of the fastest times were recorded for the no anchor line condition, NA/FAL. This can be explained by a search model where consumers know the general area of the label where the required information is located and search for the keyword identifying the value of nutrient, calorie, vitamin, and so forth. Instead, anchor lines appeared to have acted as weak distractors, evidenced by the small increase in capture times as anchor line thickness increased.

There was no evidence to support an interaction between the anchor lines and the removal or any or all of the alignment lines. Anchor lines remained in full thickness as the alignment lines were manipulated without resulting in significant increase or decrease in search times at the top or bottom of the labels. Should the alignment lines be in balance with the anchoring lines, search times would have increased significantly as the number of alignment lines were reduced. This did not occur.

The anchor lines were expected to be useful in locating information for the highly experienced subjects familiar with the layout of the labels, but there was no evidence that

they helped. In fact, some of the fastest times were made on labels without anchoring lines. In addition, there was no evidence that the removal of the alignment lines created anchors to act as strong distractors because capture times did not change for the top or bottom targets when the alignment lines were removed wholly or partially.

Fastest capture times were found for the no anchor line condition and slowest for full anchor line conditions. Future study should investigate the effects selective, bold highlighting have on locating information. Selectively highlighted text, as a salient feature, may have popped-out as anchor line thickness diminished. The features incorporated into the constant chunk information may play a larger role in information search than the anchor lines. Further study should be directed to testing the effect of the selective highlighting to test the interaction between the ruled lines and the highlighted text.

There was no support for anchors as strong distractors. This can partly be explained by the nature of the anchors. This study utilized anchor line thickness as a measure of distractor strength. Targets in Krose's (1986) study, where he found more fixations were required to locate targets with strong distractors in the field, were geometric shapes with distractors that shared parts of that same pattern. The seven point line (assumed a strong distractor) was nearly as thick as upper case letters, the three point line (medium distractor) was more in line with lower case letters, and the one-quarter point line (weak distractor) was the same thickness as the alignment lines. However, since the targets were alphanumeric characters while the anchors were lines, they did not share features. Apparently, subjects were able to process the alphanumeric characters while not attending to the ruled lines.

4.3. Landing Distance

Results relating to landing distance can be explained in two different ways. Experienced subjects were expected to land nearer the target, based on a theory that they already possessed a mental model of the target location. However, with distractors of varying strength in the vicinity of the target, a short landing distance might be a signal of the actual difficulty of the condition where closer landing distances are required for correct response formulation. Landing distance did not show a strong correlation with response accuracy. This could be because condition was so easy that landing distances were outside the 2.5 degree constraint and were not captured by this study. Another plausible explanation is that landing further from the target but still processing the correct answer could be a sign that stimulus condition did not strongly distract the subjects from the search task.

Landing distance criteria for constraining the data analyzed in this research may have been too conservative. Due to the limiting of captures to an absolute angular distance of 2.5 degrees from capture fixation mean distance to target center, 311 (19%) trials where subjects responded correctly but did not land within the capture range were discarded. However, 70 percent of the targets were correctly located and correct responses made at 2.5 degrees or closer.

4.4. Between Subject Differences

Subjects with high experience landed closer to the targets, arrived there faster and stayed on the capture fixation longer than subjects at lower experience level. In fact, the

search and capture phase of their search was completed about the same time that the less experienced subjects completed their search phase. Familiarity with the labels apparently made a difference as the number of correct responses for experienced subjects exceeded the correct responses for less experienced subjects. Whereas less experienced subjects were mainly focused on finding the target and then having time to formulate a correct response, the experienced subjects knew where to locate the targets and were able to spend more time ensuring their responses were correct because of the larger dwell times they exhibited on the capture fixation.

There was a speed-accuracy tradeoff with regard capture fixation time. Results indicate that capture fixations for subjects with low experience were not as long as for the experienced subjects, yet they could make correct responses with the shorter capture fixation times.

Even though individual variance did not allow for an expert-novice significance level, the number of correct responses was highly in favor of the subjects with high experience, recording 55 percent of all the correct responses. Overall, the changes to the labels affected subjects at both experience levels. That is, although highly experienced subjects were faster than their less experienced counterparts, search times increased for both groups, showing that the search strategies utilized must have been similar.

4.5. Model

Applying the findings from Bender and Derby (1992) that a large percentage of shoppers used nutrition label information to avoid purchasing foods may lend credence to a two-phase comparison model of choosing a food for purchase. The first comparison is the

examination of the calories and fat content of the item. Times for locating targets at the top of labels, where fat and calorie information is found, were fastest out of all target locations. Since the same number of chunks of variable information were located both the top and bottom sections of food labels, the faster times may have been due to familiarity of those items by all subjects. Whereas the subjects with low experience might only employ the single comparison for fat of calories and base a buy decision on this information, the experienced subjects, who utilize nutrition information to plan healthful diets, might start there also but then make additional comparisons. If the food item is too high in these first two items, the food may be rejected without further nutritional comparisons. If the food item's calories and fat are within the range the consumer was looking for, further comparison for nutrition content may then ensue. This two-tiered processing means that consumers examine many more items for information located at the top of labels and only look further if that information is within a preset personal range. The faster times for targets in the top locations could also be due to the American reading bias of top to bottom, left to right and the subjects may head for the top of the label even though they know the target is elsewhere. Even the subjects who rated themselves as having low experience utilizing nutrition label information still identified they were familiar with calories and fat content. Subjects with low experience who are not inclined to plan food menus based on nutrition information would exhibit a one-step process while consumers who used nutrition information to make purchasing decisions would take the two-step approach.

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Appendix A

HUMAN SUBJECTS USE APPROVAL AND INFORMED CONSENT LETTERS

PENNSTATE

1855

Senior Vice President for Research and
Dean of the Graduate School
Office for Regulatory Compliance

(814) 865-1775
Fax: (814) 863-8699

The Pennsylvania State University
212 Kern Graduate Building
University Park, PA 16802-3301

Date: July 3, 1996

From: Candice A. Yekel, Compliance Coordinator

To: Robert E. Zak

Subject: Results of Review of Proposal - Expedited **(#960599-00)**
Approval Expiration Date: July 3, 1997

"Visual Scanning in Consumer Labels"

The Biomedical Committee of the Institutional Review Board has reviewed and approved your proposal for use of human subjects in your research. **This approval has been granted for a one-year period.**

Approval for use of human subjects in this research is given for a period covering one year from today. If your study extends beyond this approval period, you must contact this office to request an annual review of this research.

Attached are mailing labels you can use to forward to 212 Kern Graduate Building the original, signed informed consent forms obtained from the subjects of your study. Contact this office if you need more labels.

Subjects must receive a **copy** of any informed consent documentation that was submitted to the Compliance Office for review.

By accepting this decision you agree to notify the Compliance Office of (1) any additions or changes in procedures for your study that modify the subjects' risks in any way and (2) any events that affect the safety or well-being of subjects.

On behalf of the committee and the University, I thank you for your efforts to conduct your research in compliance with the federal regulations that have been established for the protection of human subjects.

CAY/jls

Attachments

cc: J. H. Goldberg
A. L. Soyster
M. M. Reischman

Informed Consent Form

The Pennsylvania State University

Title of Project: Visual Scanning in Consumer Labels

Investigator: Robert E. Zak, Capt, USAF (Dr. Joseph H. Goldberg, adviser)
Department of Industrial & Manufacturing Engineering
207 Hammond Building
863-2740, rez102@psu.edu

1. This section provides an explanation of the study in which you will be participating.

A. The study in which you will be participating is part of research intended to model the scanning patterns of individuals reading consumer labels.

B. If you agree to take part in this research, you will be asked to view a series of images on a personal computer (PC) display that will involve looking for various items on the images. While you are observing the displays, your eye scan patterns will be recorded by a DBA Systems, Inc., PC Tracker. This system utilizes a camera which detects infrared light as it is reflected off the lens of your eye. To facilitate use of this eye tracking technique, a one-watt infrared illuminator will be directed toward your eye from the front of the camera. The infrared energy seen by your eye from this device is significantly less than your eye would see on a normal sunny day. This eye tracking technique has been used on hundreds of other subjects, and there are no documented or alleged cases of injury resulting from this eye tracking technique. After each display is observed, a question will appear on the screen. While remaining stationary in the chin rest, you will be asked to read the question and the answers. After you read the questions and answers, a blue gaze-point indicator will appear showing your gaze position. When the indicator appears, look directly at the answer you which to choose. The computer will automatically register your answer. You will have the opportunity to practice the task to familiarize yourself with the test apparatus and procedure.

C. Your participation in this research will take a total of approximately two hours. The researcher will schedule the session with you.

D. In participating in this experiment, you may experience some fatigue due to the mental demands of the test.

2. This section describes your rights as a research participant:

A. You may ask any questions about the research procedures, and these questions will be answered. Further questions should be directed to Dr. Joseph H. Goldberg, 207 Hammond Bldg., Tel. 863-2370, e-mail jhg2@PSU.EDU.

B. Your participation in this research is confidential. Only the person in charge will have access to your identity and to information that can be associated with your identity. In the event of publication of this research, no personally identifying information will be disclosed. To make sure your participation is confidential, only a code number is associated with your responses in the tasks. Only the researchers can match names with code numbers.

C. Your participation is voluntary. You are free to stop participating in the research at any time, or to decline to answer any specific questions without penalty.

D. This study involves minimal risk; that is, no risks to your physical or mental health beyond those encountered in the course of everyday life. The infrared energy from the infrared illuminator on the camera is less than what your eye would see on a normal sunny day.

F. I understand that medical care is available in the event of injury resulting from research but that neither financial compensation nor free medical treatment is provided. I also understand that I am not waiving any rights I may have against the University for injury resulting from negligence of the University or investigators.

3. This section indicated that you are giving your informed consent to participate in the research.

Participant:

I agree to participate in a scientific investigation of visual scanning in consumer labels as an authorized part of the education and research program of the Pennsylvania State University.

I understand the information given to me, and I have received answers to any questions I may have had about the procedure. I understand and agree to the conditions of this study as described.

To the best of my knowledge and belief, I have no physical or mental illness or difficulties that would increase the risk to me of participation in this study.

I understand that I will not receive any compensation for participating.

I understand that my participation in this study is voluntary, and that I may withdraw from this study at any time by notifying the person in charge.

I am 18 years of age or older.

I understand that I will receive a signed copy of this consent form.

Signature Date

Researcher:

I certify that the informed consent procedure has been followed, and that I have answered any questions from the participant as fully as possible.

Signature Date

Appendix B

BACKGROUND QUESTIONNAIRE

Name: ______________________________________

Number at which you can be reached: ____________________

The following questions ask about you and your nutritional habits. Please circle your answer or fill in the blank as indicated. Please answer all questions. Your answers will be completely confidential.

1. What is your gender?

   A. Male
   B. Female

2. Your present age: ________Years Occupation:________________________

3. Marital Status

   A. Married
   B. Widowed, divorced or separated
   C. Never married

4. Do you live:

   A. Alone
   B. With parents
   C. With less than 3 people (family/friends)
   D. Share house/apartment with more than 3 people (family/friends)
   E. In a group arrangement (dorm, etc.)

5. How often do you, yourself, cook?

   A. Never
   B. Less than once per week
   C. One to two times per week
   D. more than twice per week

6. How frequently do you plan meals:

   A. Never
   B. Day by day
   C. Two to three days at a time
   D. One week at a time
   E. More than a week at a time

7. How often do you shop for food:

   A. Never
   B. Less than once per week
   C. One to two times per week
   D. More than two times per week

8. About how much do you spend on groceries in a week--including snacks (not at a restaurant?)

A. 0-$10
B. $11-$20
C. $21-$30
D. $31-$40
E. >$40

9. How often do you read food labels?

A. Never
B. Sometimes
C. Frequently

10. What do you look for on food labels? (Check all that apply)

A. Fat
B. Protein
C. Calories
D. Serving Size
E. Vitamins/minerals

11. Do you read food labels for: (Check all that apply)

A. Weight control
B. Blood Cholesterol/Blood Pressure control
C. Blood Sugar control
D. General health reasons
E. Other (Explain)________________________

12. How high in fat is your overall diet?

A. Very high
B. High
C. In the middle/neither high nor low
D. Low
E. Very low
F. Don't know

13. For how long have you followed a diet that is low in fat?

A. I'm not following a low fat diet (answered very high or high in Question 12 above)
B. Less than one month
C. One to six months
D. More than 6 months but less than one year
E. More than a year

14. Over the next 6 months do you plan to cut down on fats?

A. Definitely no
B. Probably no
C. Maybe
D. Probably yes
E. Definitely yes

15. How confident are you that you would be able to decrease the amount of fat in your diet during the next 6 months?

A. Extremely confident
B. Very confident
C. Somewhat confident
D. Slightly confident
E. Not confident

16. Have you tried to make any changes to lower the fat in your diet in the past six months?

A. Yes
B. No

17. If you have tried to make changes to lower fat in your diet in the last 6 months, how successful were you in making these changes?

A. Extremely successful
B. Successful
C. Slightly successful
D. Not successful
E. Haven't tried to make changes

18. Eating a lot of fried foods increases my chances of developing serious illnesses like heart disease or cancer.

A. Strongly agree
B. Agree
C. Neither agree nor disagree
D. Disagree
E. Strongly disagree

19. What I eat is one of the most important things for my health.

A. Strongly agree
B. Agree
C. Neither agree nor disagree
D. Disagree
E. Strongly disagree

20. Low-fat foods taste good

    A. Strongly agree
    B. Agree
    C. Neither agree nor disagree
    D. Disagree
    E. Strongly disagree

21. How would you rate your knowledge of the nutrient content of foods?

    A. Excellent
    B. Average
    C. Poor

Appendix C

CORRECT RESPONSES BY EXPERIENCE LEVEL

C.1. Number of correct responses for low-experience subjects.

Condition		FullAnchoring/ FullAlignment Lines			Full Anchoring/ PartialAlignment Lines			FullAnchoring/ NoAlignment Lines			No Anchoring/ FullAlignment Lines			PartialAnchoring/ FullAlignment Lines			
Presentation times	Info Content	Top	Middle	Bottom	Top	Middle	Bottom	Top	Middle	Bottom	Top	Middle	Bottom	Top	Middle	Bottom	Tot
1 second	Large	2	1	4	5	0	1	3	0	3	5	1	2	4	4	4	39
	Small	6	3	7	3	2	2	4	3	3	4	5	3	4	1	7	57
3 seconds	Large	8	8	8	5	9	3	7	5	7	8	9	8	8	9	6	108
	Small	9	9	8	8	6	9	7	7	10	9	8	8	6	5	8	117
5 seconds	Large	8	9	8	9	7	7	8	8	9	9	6	8	8	9	5	118
	Small	6	10	9	9	9	9	7	10	9	7	10	8	9	9	9	130
Totals		39	40	44	39	33	31	36	33	41	42	39	37	39	37	39	569

C.2. Number of correct responses for high-experience subjects.

Condition		FullAnchoring/ FullAlignment Lines			Full Anchoring/ PartialAlignment Lines			FullAnchoring/ NoAlignment Lines			No Anchoring/ FullAlignment Lines			PartialAnchoring/ FullAlignment Lines			
Presentation times	Info Content	Top	Middle	Bottom	Top	Middle	Bottom	Top	Middle	Bottom	Top	Middle	Bottom	Top	Middle	Bottom	Tot
1 second	Large	5	8	6	4	1	4	6	0	7	3	2	8	7	5	9	75
	Small	6	7	7	7	5	5	5	2	9	6	7	6	4	1	7	84
3 seconds	Large	8	8	10	9	5	9	9	6	8	9	9	8	10	10	9	127
	Small	9	10	9	9	8	10	7	10	10	8	9	8	8	9	8	132
5 seconds	Large	9	10	10	10	8	8	9	10	10	9	9	9	7	10	9	137
	Small	10	10	10	7	10	10	10	9	10	8	9	8	9	10	9	139
Totals		47	53	52	46	37	46	46	37	54	43	45	47	45	45	51	694

Appendix D

ANOVA TABLES OF RESULTS

D.1. ANOVA for distance from mean center of capture fixation to target.

Source	DF	Seq SS	Adj SS	Adj MS	F	p
Subject(Experience)	2	8.4963	0.8138	0.4069	0.97	0.378
Experience	1	0.7807	1.1212	1.1212	2.68	0.102
Condition	4	0.5896	0.6746	0.1686	0.40	0.806
Info Content	1	0.3990	0.3264	0.3264	0.78	0.377
Presentation time	2	0.3474	0.0346	0.0173	0.04	0.959
Target Location	2	2.7809	1.9388	0.9694	2.32	0.099
Experience *Condition	4	2.5784	1.8043	0.4511	1.08	0.365
Experience*Info Content	1	0.1644	0.4252	0.4252	1.02	0.313
Experience*Presentation Time	2	0.3961	0.2722	0.1361	0.33	0.722
Experience*Target Loc.	2	0.1029	0.0233	0.0116	0.03	0.973
Condition*Infocontent	4	6.1649	5.8744	1.4686	3.51	0.007
Condition*Presentation Time	8	3.3215	3.3630	0.4204	1.01	0.430
Condition*Target Loc.	8	4.0207	4.0329	0.5041	1.21	0.292
InfoContent*Presentation Time	2	0.3498	0.3372	0.1686	0.40	0.668
InfoContent*Target Loc.	2	0.9714	0.5258	0.2629	0.63	0.533
Presentation Time*Target Loc.	4	1.2313	0.5695	0.1424	0.34	0.851
Experience*Condition*Info Content	4	0.8633	0.9958	0.2490	0.60	0.666
Experience*Condition*Presentation Time	8	3.6309	3.3099	0.4137	0.99	0.442
Experience*Condition*Target Loc.	8	4.1232	4.2834	0.5354	1.28	0.249
Experience*InfoContent*Presentation Time	2	0.6727	0.6491	0.3245	0.78	0.460
Experience*InfoContent*TargetLoc.	2	0.4549	0.4350	0.2175	0.52	0.594
Eperience*PresentationTime*TargetLoc.	4	0.8918	0.9631	0.2408	0.58	0.680
Condition*InfoContent*Presentation Time	8	1.8065	1.7295	0.2162	0.52	0.844
Condition*InfoContent*Target Loc.	8	5.1817	4.8232	0.6029	1.44	0.175
Condition*PresentationTime*TargetLoc.	16	5.9281	5.9848	0.3741	0.89	0.575
InfoContent*Presentation Time*Target Loc.	4	0.3799	0.3799	0.0950	0.23	0.923
Error	1149	480.2324	480.2324	0.4180		
Total	1262	536.8610				

D.2. ANOVA for number of fixations until target capture.

Source	DF	Seq SS	Adj SS	Adj MS	F	p
Subject(Experience)	2	226.476	45.978	22.989	5.43	0.005
Experience	1	1.130	0.814	0.814	0.19	0.661
Condition	4	85.567	45.841	11.460	2.71	0.029
Info Content	1	5.319	5.078	5.078	1.20	0.274
Presentation time	2	367.772	254.663	127.331	30.08	0.0001
Target Location	2	146.793	87.951	43.976	10.39	0.0001
Experience *Condition	4	18.306	13.008	3.252	0.77	0.546
Experience*Info Content	1	5.463	1.838	1.838	0.43	0.510
Experience*Presentation Time	2	38.796	33.822	16.911	4.00	0.019
Experience*Target Loc.	2	31.746	14.347	7.173	1.69	0.184
Condition*Infocontent	4	35.493	39.178	9.794	2.31	0.056
Condition*Presentation Time	8	46.163	27.338	3.417	0.81	0.596
Condition*Target Loc.	8	186.426	124.527	15.566	3.68	0.0001
InfoContent*Presentation Time	2	1.342	1.091	0.546	0.13	0.879
InfoContent*Target Loc.	2	2.110	1.439	0.720	0.17	0.844
Presentation Time*Target Loc.	4	23.942	23.139	5.785	1.37	0.244
Experience*Condition*Info Content	4	29.849	30.822	7.706	1.82	0.123
Experience*Condition*Presentation Time	8	17.490	14.739	1.842	0.44	0.900
Experience*Condition*Target Loc.	8	56.910	46.717	5.840	1.38	0.201
Experience*InfoContent*Presentation Time	2	6.431	6.938	3.469	0.82	0.441
Experience*InfoContent*TargetLoc.	2	0.786	0.710	0.355	0.08	0.920
Eperience*PresentationTime*TargetLoc.	4	20.255	17.144	4.286	1.01	0.400
Condition*InfoContent*Presentation Time	8	38.270	39.499	4.937	1.17	0.316
Condition*InfoContent*Target Loc.	8	167.485	149.669	18.709	4.42	0.0001
Condition*PresentationTime*TargetLoc.	16	62.231	61.857	3.866	0.91	0.553
InfoContent*Presentation Time*Target Loc.	4	1.518	1.518	0.380	0.09	0.986
Error	1149	4863.316	4863.316	4.233		
Total	1262	6487.384				

Table D.3. ANOVA for total capture time (including capture fixation).

Source	DF	Seq SS	Adj SS	Adj MS	F	p
Subject(Experience)	2	28639880	2457557	1228779	2076	0.064
Experience	1	493257	284092	284092	0.64	0.424
Condition	4	15313861	8488239	2122060	4.77	0.001
Info Content	1	259391	199749	199749	0.45	0.503
Presentation time	2	50391724	36315964	18157982	40.81	0.0001
Target Location	2	11256303	6598405	3299203	7.41	0.001
Experience *Condition	4	305482	202571	50643	0.11	0.978
Experience*Info Content	1	760882	215160	215160	0.48	0.487
Experience*Presentation Time	2	4383762	3956636	1978318	4.45	0.012
Experience*Target Loc.	2	1503227	687389	343695	0.77	0.462
Condition*Infocontent	4	5855400	6466384	1616596	3.63	0.006
Condition*Presentation Time	8	6516240	4754474	594309	1.34	0.222
Condition*Target Loc.	8	20590822	14044769	1755596	3.95	0.0001
InfoContent*Presentation Time	2	214754	168437	84218	0.19	0.828
InfoContent*Target Loc.	2	862954	486332	243166	0.55	0.579
Presentation Time*Target Loc.	4	1028149	1224795	306199	0.69	0.600
Experience*Condition*Info Content	4	4269413	4202390	1050598	2.36	0.052
Experience*Condition*Presentation Time	8	1240297	882763	110345	0.25	0.981
Experience*Condition*Target Loc.	8	5020570	4329899	541237	1.22	0.286
Experience*InfoContent*PresentationTime	2	1263589	1183361	591680	1.33	0.265
Experience*InfoContent*TargetLoc.	2	637922	671480	335740	0.75	0.471
Eperience*PresentationTime*TargetLoc.	4	1467229	1255992	313998	0.71	0.588
Condition*InfoContent*Presentation Time	8	4860011	5041749	630219	1.42	0.185
Condition*InfoContent*Target Loc.	8	21220716	20108984	2513623	5.65	0.0001
Condition*PresentationTime*TargetLoc.	16	6658630	6661112	416320	0.94	0.527
InfoContent*PresentationTime*TargetLoc.	4	161766	161766	40441	0.09	0.985
Error	1149	511275648	511275648	444974		
Total	1262	706451904				

D.4. ANOVA for target search time up to onset of target capture fixation.

Source	DF	Seq SS	Adj SS	Adj MS	F	p
Subject(Experience)	2	35578904	2544471	1272236	3.07	0.047
Experience	1	580888	348439	348439	0.84	0.359
Condition	4	12622612	6644531	1661133	4.01	0.003
Info Content	1	209050	124393	124393	0.30	0.584
Presentation time	2	41545972	30743876	15371938	37.09	0.0001
Target Location	2	7905035	4851847	2425923	5.85	0.003
Experience *Condition	4	339909	154959	38740	0.09	0.985
Experience*Info Content	1	220066	24895	24895	0.06	0.806
Experience*Presentation Time	2	4694322	3958817	1979409	4.78	0.009
Experience*Target Loc.	2	976065	453355	226678	0.55	0.579
Condition*Infocontent	4	439707	5135474	1283869	3.10	0.015
Condition*Presentation Time	8	5596720	4367735	545967	1.32	0.231
Condition*Target Loc.	8	17534292	12371972	1546497	3.73	0.0001
InfoContent*Presentation Time	2	48834	68621	34310	0.08	0.921
InfoContent*Target Loc.	2	469704	338560	169280	0.41	0.665
Presentation Time*Target Loc.	4	684937	755195	188799	0.46	0.768
Experience*Condition*Info Content	4	3713985	3786148	946537	2.28	0.059
Experience*Condition*Presentation Time	8	930419	810830	101354	0.24	0.982
Experience*Condition*Target Loc.	8	5639850	4890974	611372	1.48	0.162
Experience*InfoContent*PresentationTime	2	964254	895979	447989	1.08	0.340
Experience*InfoContent*TargetLoc.	2	947901	921397	460699	1.11	0.329
Eperience*PresentationTime*TargetLoc.	4	764521	573664	143416	0.35	0.847
Condition*InfoContent*Presentation Time	8	4760307	5329730	666216	1.61	0.118
Condition*InfoContent*Target Loc.	8	17858100	17075098	2134387	5.15	0.0001
Condition*PresentationTime*TargetLoc.	16	5162751	5099601	318725	0.77	0.722
InfoContent*PresentationTime*TargetLoc.	4	154910	154910	38727	0.09	0.985
Error	1149	476151392	476151392	414405		
Total	1262	650449408				

D.5. ANOVA for time of initial capture fixation.

Source	DF	Seq SS	Adj SS	Adj MS	F	p
Subject(Experience)	2	631423	244132	122066	3.42	0.033
Experience	1	3581	3282	3282	0.09	0.762
Condition	4	307922	176784	44196	1.24	0.293
Info Content	1	2713	8881	8881	0.25	0.618
Presentation time	2	426561	236043	118022	3.31	0.037
Target Location	2	297193	138812	69406	1.94	0.144
Experience *Condition	4	153907	134150	33537	0.94	0.440
Experience*Info Content	1	162549	93679	93679	2.63	0.105
Experience*Presentation Time	2	60142	52463	26232	0.74	0.480
Experience*Target Loc.	2	89187	45487	22743	0.64	0.529
Condition*Infocontent	4	253942	125901	31475	0.88	0.474
Condition*Presentation Time	8	204693	148698	18587	0.52	0.841
Condition*Target Loc.	8	278955	137061	17133	0.48	0.871
InfoContent*Presentation Time	2	61668	22042	11021	0.31	0.734
InfoContent*Target Loc.	2	131520	74329	37165	1.04	0.353
Presentation Time*Target Loc.	4	75681	79796	19949	0.56	0.692
Experience*Condition*Info Content	4	60009	79081	19770	0.55	0.696
Experience*Condition*Presentation Time	8	123028	93079	11635	0.33	0.956
Experience*Condition*Target Loc.	8	367621	400774	50097	1.40	0.191
Experience*InfoContent*Presentation Time	2	49761	41434	20717	0.58	0.560
Experience*InfoContent*TargetLoc.	2	211758	194661	97331	2.73	0.066
Experience*PresentationTime*TargetLoc.	4	383618	392718	98179	2.75	0.027
Condition*InfoContent*Presentation Time	8	186599	128006	16001	0.45	0.892
Condition*InfoContent*Target Loc.	8	434666	392515	49064	1.37	0.203
Condition*PresentationTime*TargetLoc.	16	227226	225036	14065	0.39	0.984
InfoContent*Presentation Time*Target Loc.	4	126203	126203	31551	0.88	0.473
Error	1149	41002248	41002248	35685		
Total	1262	46314376				